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ESTIMATING AND BIDDING FOR THE SPACE STATION PROCESSING
FACILITY

IN-81-TM

OR

190597

SPACE STATION PROCESSING FACILITY GOVERNMENT ESTIMATING

p. 99

OR

AEROSPACE PRICE BOOK - VOLUME IV

OR

HOW THE GOVERNMENT ESTIMATING WAS SO ACCURATE

OR

HOW THE LOW BIDDER GOT LOW ON SSPF

FOR

AACE INTERNATIONAL 37TH ANNUAL MEETING

DEARBORN, MICHIGAN

JULY 11 - 14, 1993

BY

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SENIOR ADVISOR AND COORDINATOR FOR DEVELOPMENT OF COST ENGINEERING
AND ESTIMATES

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KENNEDY SPACE CENTER, FL 32899-0001

(NASA-TM-109323) ESTIMATING AND
BIDDING FOR THE SPACE STATION
PROCESSING FACILITY (NASA) 29 p

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Estimating and Bidding for the Space Station Processing Facility

by

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INTRODUCTION

This new, unique Cost Engineering Report introduces the 800-page, C-100 government estimate for the Space Station Processing Facility (SSPF) and Volume IV Aerospace Construction Price Book. At the January 23, 1991, bid opening for the SSPF, the government cost estimate of \$56,861,983 was right on target. Metric, Inc., Prime Contractor, low bid of \$56,215,000 was 1.2% below the government estimate. This project contains many different and complex systems. Volume IV is a summary of the cost associated with construction, activation and Ground Support Equipment (GSE) design, estimating, fabrication, installation, testing, termination, and verification of this over \$380,000,000 (including GSE and activation) project. Included are 13 reasons the government estimate was so accurate; abstract of bids, for 8 bidders and government estimate with additive alternates, special labor and materials, budget comparison and system summaries; and comments on the \$350,000 energy credit from local electrical utility. This report adds another project to our continuing study of "How Does the Low Bidder Get Low and Make Money?" which was started in 1967, and first published in the 1973 AACE Transaction with 10 more ways the low bidder got low. The accuracy of this estimate proves the benefits of our Kennedy Space Center (KSC) teamwork efforts and KSC Cost Engineer Tools which are contributing toward our goals of the Space Station.

BACKGROUND - SSPF ESTIMATING HISTORY

Some background on the history of budget and preliminary cost estimating is shown in the following chart of comparison of budgeted and estimating cost of the Space Station Processing Facility (SSPF). The budget was developed by John F. Kennedy Space Center from 1983 to 1985 at \$63,200,000 for a 298,000 square foot facility. The Preliminary Engineering Report of June 30, 1986, further defined the requirements. However the scope changed several times adding a cafeteria, air lock, and office mezzanine as shown in Figure I with the 30%, 60%, 90% and 95% design estimates.

FIGURE I - BUDGET COMPARISON PART I

FIGURE I

COMPARISON OF BUDGETED AND ESTIMATED COSTS

DRAWING NO.	W/O CONTRACT	ARCH/ENG.	NASAPEREZ, DF-FED-32 867-2477	PCN	ESTIMATOR	LOCATION	KSC INDUSTRIAL AREA, NASA CAUSEWAY, EAST OF O&C	PROJECT	MAIN BLDG. SPACE STATION PROCESSING FAC.	C-100	
										08/09/90	09/24/90
NAS10-11800	JACOBS ENG, RALPH HAHN ASSOC, MACDONNELL DOUGLAS	JACOBS ENG, RALPH HAHN ASSOC, MACDONNELL DOUGLAS	06/24/86	93268	GRUMBACH, JACOBS	VARNDELL, EG&G	JONES, EG&G	SPACE STATION PROCESSING FAC.	SPACE STATION PROCESSING FAC.	08/02/91	09/24/90
BUDGETED LINE ITEMS	BUDGETED COSTS	BUDGETED COSTS	PER	07/03/88	01/17/89	07/01/89	10/01/89	08/09/90	09/24/90	08/02/91	09/24/90
	JACOBS	PROJECT		CODE C-30	CODE C-60	CODE C-90	CODE C-95	CODE REV. C-95	CODE C-100		REMARKS
SITE WORK	-	1,559,957	1,559,957	1,758,935	1,369,717	4,226,098	4,723,636	3,741,814	3,741,814		
UTILITIES OUTSIDE 5' LINE	-	2,766,672	2,766,672	1,132,497	2,180,805	3,082,216	3,198,841	3,103,329	3,103,329		
STRUCTURE TO 5' LINE	-	32,680,507	32,680,507	39,614,913	39,998,979	48,132,821	49,238,683	42,280,448	45,222,214		
SUBTOTAL	-	37,015,136	37,015,136	42,506,045	43,549,501	55,441,135	57,161,160	49,125,591	52,067,367		
VISITOR VIEWING GALLERY	-	-	-	-	-	-	1,406,418	953,784	1,184,662		
CAFETERIA	-	-	-	-	-	-	1,583,953	1,048,035	1,043,801		
SUBTOTAL INCL. VVG & CAF.	-	-	-	-	-	-	60,151,531	51,127,410	54,295,830		
TASK VI AMEND 12500 TON CHILLER	-	-	-	-	-	-	-	-	-		
TASK VII ALT 2 P. FEEDER	2,000,000	-	-	-	-	-	-	500,000	1,224,231		
ALT I 2ND CHILLER	800,000	-	-	-	-	-	-	800,000	617,199		
R&D AND R&PM	2,500,000	-	-	-	-	-	-	2,500,000	1,714,958		
PHASE I (ESTIMATE)	7,000,000	-	-	-	-	-	5,078,913	4,424,338	5,078,913		
ECBC	38,262,805	38,262,805	37,015,136	45,927,986	46,971,442	55,441,135	65,230,444	59,351,748	62,931,131		
ESCAL & SPEC. COND.	10,968,600	10,968,600	10,214,384	8,075,788	8,666,351	11,032,786	7,045,146	6,721,712	7,184,347		
CRANES	3,000,000	3,000,000	3,200,000	3,200,000	3,202,000	3,082,080	3,082,080	3,082,080	3,082,080		
ECBC INCL ESCAL & S.C.	52,231,405	64,531,405	50,429,520	57,203,774	58,839,783	69,566,001	75,367,670	69,185,540	73,207,558		JACOBS
GFE	1,500,000	1,500,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000		GFE N.I.C.
TASK II HVAC CONTROL	500,000	500,000	-	-	-	-	-	500,000	395,495		R. HAHN A&E
TASK III PREMISE WIRING	2,500,000	2,500,000	-	-	-	-	-	2,500,000	1,766,968		M.D. A&E
TASK IV SECURITY SYST.	150,000	150,000	-	-	-	-	-	150,000	98,956		M.D. A&E
TASK V ENVIRO. MONITORING	100,000	100,000	-	-	-	-	-	100,000	55,237		M.D. A&E
SUBTOTAL	52,231,405	69,281,405	51,429,520	58,203,774	59,839,793	70,566,001	76,367,670	73,415,540	76,524,214		
CONTINGENCY	5,223,141	6,928,141	5,142,952	5,820,377	5,983,979	7,056,600	7,636,767	7,341,554	7,652,421		
S&A	5,745,455	7,620,955	5,657,247	6,402,415	6,582,377	7,762,260	8,400,444	8,075,709	8,417,664		
CCE	63,200,001	83,830,501	62,229,719	70,426,566	72,406,149	85,384,861	92,404,981	88,832,803	92,594,299		
PCT. DIFFERENCE BUDGETED/ESTIMATED TOTALS											
NOTES: (1) 52,231,405 JACOBS CONTRACT COST LIMIT (2/9/88)											
(2) ORIGINAL BLDG CONTAINED 298,000 SF PER & 30% (\$172.58 SF COST)											
(3) SCOPE CHANGED AT 60%, INCREASED SIZE TO 312,396 SF (\$1.91 SF COST)											
(4) ABOUT 75% ADDED 3RD FLR & LARGER CAFETERIA,											
SCOPE CHANGE TO 440,000 SF (\$160.58 SF COST)											
(5) WHOLE NEW EST., RECESSION & MARKET EVAL. PT&I INCREASE, NEW QUOTES, STEEL, ETC.											
(6) R&D, R&PM ITEMS FROM C OF F TO OTHER FUNDING											
(7) IFB ISSUED 6/1/90											
(8) 82,120,889 - 9/18/90 REV. JACOBS CONTRACT LIMIT											
(9) ORIGINAL CALLED FOR 2-1500 TON CARRIER CHANGED TO 1-2500 TON											
(10) ADDED A 2ND 2500 TON YORK CHILLER											
(11) SCOPE CHANGED AGAIN AT 90% INCREASED TO 457,415 SF (154.27 SF COST)											
(12) 100% GOVT. EST. IS BASED ON 457,415 SF (\$124.31 SF COST)											
(13) CRANE NOT IN CONSTRUCTION IFB											
(14) BASED ON GOOD OPEN SHOP WITH 10 OR MORE BIDS											
(15) BASED ON 2 BIDDERS CLOSED SHOP \$50 BARREL FOR OIL (KUWAIT INVASION)											
(16) PHASE I ADDED TO SITE & UTILITIES, NOT SEPARATE CONTRACT											
(17) SPEC. COND. NOT NECESSARY DUE TO BID CONDITION OVER 6 BIDDERS											
(18) REDUCE PROFIT BY 4% & 4% VOLUME DISCOUNT - LARGE PROJECT											
(19) () NOT IN TOTAL FIGURES											
(20) JACOBS BUDGET EST. DESIGN CONTRACT COST LIMIT											
(21) 65,889,366 THREE A&E'S C-100 ESTIMATE											

STUDY OF GOVERNMENT ESTIMATING AND BIDDING

In mid 1990 as the Space Station Processing Facility (SSPF) design was nearing completion a decision was made to make a special study for improving the accuracy of Government Estimates (Figure 4). The five areas studied were: 1. based on Dr. Martin Skidmore's 1988 reports and center on the bidding and number of bidders, 2. special studies and analysis of previous and current Government Estimates, 3. special studies of low bidder cost estimating, 4. independent analysis of what would the bids be, and 5. specifying what the low bid would be, what the medium bid would be, and what would the high bid be (shown in Figure II). Another area of study is the special review and analysis of the Government Estimates that become the Official Government Estimate.

Dr. R. M. Skitmore, analysis of estimating accuracy based on number of bidders, by contract sum or dollar amount, and by contract period or length of schedule led to an independent study of potential bidders for the SSPF; five lists of potential bidders were used:

1. Source list of 31 pages - 685 sets of half size plans and specifications were sent out to potential bidders - about 30 appeared to be prime contractor bidders
2. Pre-Bid Conference, September 13, 1990 - 14 page list with 7 prime bidders and subs, vendors, etc.
3. Print Shops full size drawing and specification sets - requests at \$580.00 a set list has 12 prime bidders
4. Questions from 6 prime bidders, subs and vendors
5. Dodge reports list 10 prime's receiving sub bids

SUBSEQUENTLY A LIST OF PROSPECTIVE PRIME BIDDERS FOR THE SPACE STATION PROCESSING FACILITY WAS DEVELOPED

The following list is based on a summation of the previous 5 list of potential bidders: 1. Morrison Knudson (3L-6S), 2. Blout (3L, 4S), 3. W&J (3L), 4. Walsh (4L, 2PS), 5. Auchter (3L), 6. F. J. Rooney (4L, 2S), 7. Taylor Woodrow (3L, 2S), 8. Kiewit NEB (3L), 9. Flour Daniel (1L), 10. Sauer (4L), 11. George Hyman, Tampa (4L 4 Sets), 12. University Mechanical National (1L, 3S), 13. Metric Construction, Tampa (2L), 14. Caddell Construction, AL (3L).

Note: The first number in parenthesis is the number from the 1 through 5 list above, the second number in parenthesis is the number of sets of full size drawings and specifications ordered by the bidder.

THE SUMMARY OF A SPECIAL STUDY AND ANALYSIS OF LOW BIDDERS ESTIMATES FROM KSC COST INDEXES

1. Errors in judgement
2. Mistakes in estimating and bidding
3. Low mark-ups (crew rates, overhead, profit)
4. No sales tax, lower or high PT&I rates
5. Heavy competition by vendors and subcontractors
6. High-balling and low-balling by vendors, subcontractors and contractors

7. Computer Estimating and bidding:
 - a. Using such programs as Timberline to bid and get more jobs
 - b. Using such scheduling programs as Primavera to get schedule cost estimating
 - c. Bringing in company computer experts to ensure bidding accuracy and speed in getting final bid
 - d. Using a computer estimating program to get trend ratios of reduction of cuts, subs and quotes with projection to bid time, so bid estimates could be prepared hours early
8. Summarized the project cost estimate using the 16 specification division, such as 1 overhead, 2 site work, 3 concrete, 5 steel, 15 mechanical, 16 electric
9. Assuming in-house sub work to get better sub bids
10. Letting sub take value engineer (VE) risks and giving them the potential savings
11. Special sub bid analysis
12. Companies with outside experience and work, such as process, industrial, etc. getting extra good quotes and volume discounts for the KSC work
13. Bidding extra low to get other future KSC work
14. New construction methods and applications to help cut costs to get more jobs and make money
15. Intentional mistakes on sub bids to let the low bidder off the hook or to allow the general contractor to get the best sub-bids and quotes the day after the bids
16. Bid shopping, bid peddling, bid cutting, cut throat practices, resulting in anger, bitterness, ill will, and cheap substitutions
17. Assuming extra claims and higher change order costs will make the profit

CONTINUING SPECIAL ANALYSIS OF GOVERNMENT ESTIMATES 1989-1991 TO IMPROVE ACCURACY

1. Poor quotes - too high, not enough; should be three quotes on all major cost items to prevent sole source items, to get best discounts and ensure specified items are available
2. Poor breakdowns on major cost items
3. High labor hours - especially mechanical and electrical
4. High mark-ups for taxes, insurance, overhead, and profit
5. Errors in math - quantities, extensions, etc.
6. Sole source items - every effort should be made to have "or equal" items listed on drawings and alternates designs
7. High electrical cost estimates on 4 of 5 recent bids
8. Paving projects - quantities should be figured in square yards and tons due to extra claims on leveling course of pavement
9. Payroll taxes and insurance (PT&I) - Some to high and some to low

Special analysis of estimating independent study - what would the low bid estimate be, medium bid be and high bid be, October 22, 1990, See Figure II. The low estimate of \$51,980,000 based on 10 or more bids - good open shop bidder, the medium estimate of \$55,116,650, the high estimate of \$63,855,000, only 2 bidders, closed shop. Note the C100 A&E estimate of November 12, 1990, was \$65,889,576.

FIGURE II

COMPARISON OF BUDGETED AND ESTIMATED COSTS

DRAWING NO.		PCN		LOCATION		INDUSTRIAL AREA, PROJECT		MAIN BUILDING	
79K32598 -814 SHTS, 79K33032 -20 SHTS, 79K33144 -4 SHTS		93268		NASA CAUSEWAY, EAST OF O&C		SPACE STATION PROCESSING FAC.		JONES, EG&G	
82K00912 -76 SHTS, 82K00913 -12 SHTS, 82K00914 -11 SHTS, TOTAL 933 SHTS		ESTIMATOR		CHECKER		CODE		C-100	
W/O/CONTRACT		GRUMBACH, JACOBS		DURBIN, JACOBS		SUBMITTED		8/2/91	
NASA10-11800		NASA PERZ, DF-FED-32 867-2477		10/01/89					
ARCH./ENG.		MACDONNELL DOUGLAS		ANALYSIS 10/22/90 ESTIMATED BID RANGE					
JACOBS ENG, RALPH HAHN ASSOC.				LOW		MEDIUM		HIGH	
BUDGETED LINE ITEMS		BUDGETED COSTS		LOW		MEDIUM		HIGH	
				2,700,000		3,000,000		3,500,000	
SITE WORK				250,000		2,500,000		3,500,000	
UTILITIES OUTSIDE 5' LINE				39,640,000		39,750,000		44,800,000	
STRUCTURE TO 5' LINE				42,590,000		45,250,000		51,800,000	
SUBTOTAL				1,000,000		950,000		1,200,000	
VISITOR VIEWING GALLERY				1,040,000		1,050,000		1,400,000	
CAFETERIA				44,630,000		47,250,000		54,400,000	
SUBTOTAL INCL. VVG & CAFE.				980,000		980,000		980,000	
TASK VI AMEND 12500 TON CHILLER				620,000		620,000		650,000	
TASK VII/ALT 2 P. FEEDER				1,250,000		900,000		1,500,000	
ALT I 2ND CHILLER				2,500,000		2,500,000		2,500,000	
R&D AND R&PM									
PHASE I (ESTIMATE)									
ECBC				49,980,000		52,250,000		60,030,000	
ESCAL & SPEC. COND.						550,000		1,300,000	
CRANES				(2,500,000)		(2,500,000)		(2,500,000)	
ECBC INCL ESCAL & S.C.				49,980,000		52,800,000		61,330,000	
GFE									
TASK II HVAC CONTROL				350,000		395,492		500,000	
TASK III PREMISE WIRING				1,500,000		1,766,968		1,800,000	
TASK IV SECURITY SYST.				100,000		98,956		125,000	
TASK V ENVIRO. MONITORING				50,000		55,237		100,000	
SUBTOTAL				51,980,000		55,116,653		63,855,000	
CONTINGENCY				5,198,000		5,511,665		6,385,500	
S&A				5,717,800		6,062,832		7,024,050	
CCE				62,895,800		66,691,150		77,264,550	
PCT. DIFFERENCE BUDGETED/ESTIMATED TOTALS									
NOTES: (1) 52,231,405 JACOBS CONTRACT COST LIMIT (2/9/88)									
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(6) R&D, R&PM ITEMS FROM C OF F TO OTHER FUNDING									
(7) IFB ISSUED 8/1/90									
(8) 82,120,889 - 9/18/90 REV. JACOBS CONTRACT LIMIT									
(9) ORIGINAL CALLED FOR 2-1500 TON CARRIER CHANGED TO 1-2500 TON									
(10) ADDED A 2ND 2500 TON YORK CHILLER									
(11) SCOPE CHANGED AGAIN AT 90% INCREASED TO 457,415 SF (154.27 SF COST)									
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(13) CRANE NOT IN CONSTRUCTION IFB									
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(17) SPEC. COND. NOT NECESSARY DUE TO BID CONDITION COVER 6 BIDDERS									
(18) REDUCE PROFIT BY 4% & 4% VOLUME DISCOUNT - LARGE PROJECT									
(19) () NOT IN TOTAL FIGURES									
(20) JACOBS BUDGET EST. DESIGN CONTRACT COST LIMIT									
(21) 65,889,366 THREE A&E'S C-100 ESTIMATE									

ANALYSIS SUMMARY OF DETAIL STUDY ON GOVERNMENT ESTIMATING, NUMBER OF BIDDERS STUDY, AND LOW BIDDERS ESTIMATING AND CONSTRUCTION ECONOMY-MARKET

1. Over 7 bidders, therefore the price would be 7% to 22% lower than the average government estimate, per number of bidders charts, or extra the competition reduces the bid price 7% to 22% (see Chart Page 9 - Number of Bidders).

2. Plenty of open shop bidders therefore 30% premium for union type bidders is not necessary (not union price) (see Aerospace Construction Cost Estimating).

3. Very good competition, hungry market, middle east Kuwait/Desert Storm conflict should not effect price or add escalation. Barrel/price of oil should stay \$20.00 to \$25.00 a barrel.

4. Increase Emphasis on more and better budget quotes breakdown on major cost items in the Government Estimate.

5. Bidding mark-ups can be reduced - Overhead from 15% to 10%, profit and prime mark-up reduced volume, discount should be included 2% - 10%. (VAB government estimate used 3% profit) (see Figure III and Launch Pad to Moon - Bidding Cost of VAB) - See OPF System Summary used 3% overhead and 5% profit, see Aerospace Price Book Volume III, Sheet 2, Bid May 14, 1975. SEE PAGE 28

6. Special condition of 3% - 10% not needed. Normally used during boom time construction when few bidders. (See Figure III) Labor and material summary shows no special conditions were used. Also see Government Bid Estimates Compared to General Contractor Bid Estimates, AACE 33rd Meeting, and Contractor Analysis Chart by Perez and Brown.

SEE PAGE 27 - COMPUTER ANALYSIS LDE/LCE

FIGURE III

LABOR AND MATERIAL COST SUMMARY FOR BUILDINGS

DRAWING NO. 79K32598	SHEETS 813 + EO'S		PCN 93268	LOCATION KSC INDUSTRIAL AREA, NASA CAUSEWAY, EAST OF O&C		PROJECT SPACE STATION PROCESSING FACILITY								
	ARCH./ENG. NASA PEREZ, DF-FED-32 867-2477			ESTIMATOR VARDELL, EG&G		CHECKER JONES, EG&G								
	JACOBS ENG, RALPH HAHN ASSOC, MACDONNELL DOUGL			GRUMBACH, JACOBS		DURBIN, JACOBS								
LINE ITEM	SITWORK		ARCHIT./STRUCT.		MECHANICAL		ELECTRICAL		SPECIALIZED CONSTR.		OTHER		PROJECT TOTALS	
	LABOR	MATERIAL	LABOR	MATERIAL	LABOR	MATERIAL	LABOR	MATERIAL	LABOR	MATERIAL	LABOR	MATERIAL		TASK VI - VII
SITE WORK	1,005,530	1,163,152												2,168,682
ARCH./STRUCT.			5,739,577	14,312,610										20,052,187
INTERIOR MECHANICAL														
A/C					2,417,679	3,549,229								5,966,908
PLUMBING					500,236	355,985								856,221
FIRE PROTECTION					322,457	357,067								679,524
VACUUM SYSTEM					98,596	386,722								485,318
INTERIOR ELECTRICAL R&D PAGING/UPS/ POWER CLUSTER										141,867	331,356			473,223
POWER & LIGHT							1,175,938	1,945,565						3,121,503
INSTR. & COMM.							120,971	210,015						330,986
EXTERIOR UTILITIES														
MECH. FIRE LINE S&W	151,693	376,668			32,615	51,535								612,511
ELECTRICAL														
POWER & LIGHT							147,090	1,246,741						1,393,831
INSTR. & COMM.							101,027	101,165						202,192
SPECIALIZED CONSTR.														
STRUC. OFFICE FURN.														
MECHANICAL TASK VI, 2500 TON CHILLER													3,010,907	3,010,907
ELECTRICAL TASK VII, POWER FEEDER													73,756	1,143,100
NITROGEN/HELIUM VENTS													70,862	259,681
SUBTOTAL, LABOR	1,157,223		5,739,577		3,371,583		1,545,026			213,994	307,107		144,618	521,101
SUBTOTAL, MATERIAL		1,539,820		14,312,610		4,700,538		3,503,486		355,861	3,649,370		1,258,163	28,963,987
SALES TAX 6%		92,389		858,757		282,032		210,209			218,962		75,490	1,737,839
PT&I 30%	347,167		1,721,873		1,011,475		386,257 (25%)			106,758			43,385	3,616,915
SUBTOTAL	1,504,390	1,632,209	7,461,450	15,171,367	4,383,058	4,982,570	1,931,283	3,713,695		462,619	3,868,332		1,333,653	
TOTAL		3,136,599		22,632,817		9,365,628		5,644,978			4,330,951		1,521,656	46,632,629
CONTR. OVERHEAD 10%		313,660		2,263,282		936,563		564,498			433,095		152,166	4,663,264
SUBTOTAL		3,450,259		24,896,099		10,302,191		6,209,476			4,764,046		1,673,822	51,295,893
CONTR. PROFIT 7%		241,518		1,742,727		721,153		434,663			333,483		117,168	3,590,712
SUBTOTAL		3,691,777		26,638,826		11,023,344		6,644,139			5,097,529		1,790,990	54,886,605
PRIME MARKUP 5%		184,589		N/A		551,167		332,207			254,876		89,550	1,412,389
SUBTOTAL		3,876,366		26,638,826		11,574,511		6,976,346			5,352,405		1,880,540	56,298,994
BOND 1%		38,764		266,388		115,745		69,763			53,524		18,805	562,989
TOTAL		3,915,130		26,905,214		11,690,256		7,046,109			5,405,929		1,899,345	56,861,983

NOTES
INCLUDES MAIN BUILDING, CAFETERIA, VVG, AND R&D ITEMS

ABSTRACT OF BIDS

BID OPENING: 1-23-91 - SPACE STATION PROCESSING FACILITY

IFB 10-0055-0

PCN 93268

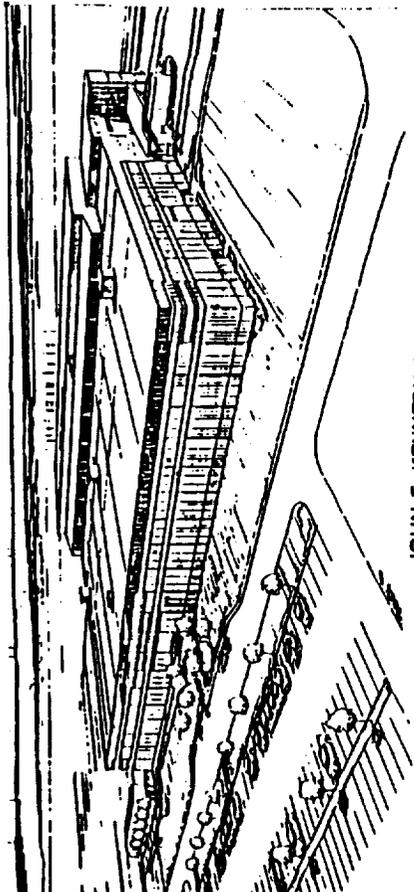
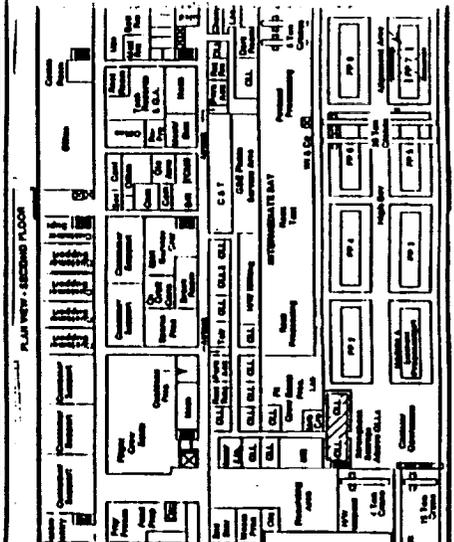
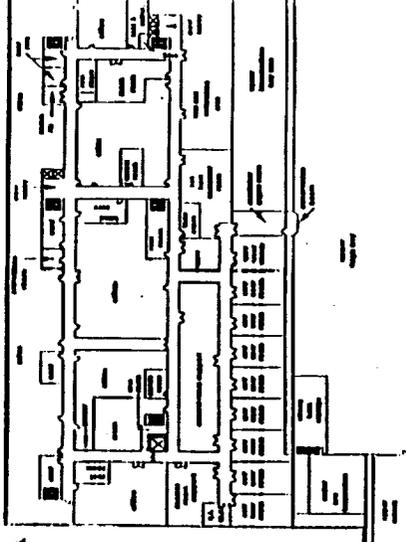
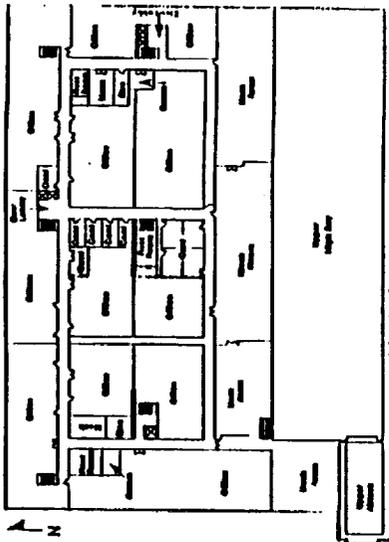
ADVERTISE DATE: 8/1/90

<u>Contractor</u>	<u>Task I-V</u> Base Bid	<u>Task VI</u> Additive 2500-T Chiller	<u>Task VII</u> Additive Power Feeder	<u>Total Bid</u>	<u>* Gov. CE</u>
1. Metric Const. Tampa, FL	\$54,780,000	\$1,150,000	\$285,000	\$56,215,000	- 1.2%
2. Govt. Est., Jacobs/Hahn/MDAC	\$54,508,886	\$1,735,898	\$617,199	\$56,861,983	0
3. W&J Const. Cocoa, FL	\$55,955,000	\$1,300,000	\$330,000	\$57,585,000	+ 1.3%
4. Blount Bros. Montgomery, AL	\$56,998,000	\$1,400,000	\$400,000	\$58,798,000	+ 3.4%
5. Centex-Rooney Ft. Lauderdale, FL	\$57,627,000	\$1,216,000	\$327,000	\$59,170,000	+ 4.1%
6. Sovran Const. Winter Park, FL	\$58,341,058	\$1,283,228	\$331,290	\$59,955,576	+ 5.4%
7. Caddell/Hardway Montgomery, AL	\$60,498,000	\$1,295,200	\$315,000	\$62,108,000	+ 9.2%
8. Walsh Const. Trumbly, CT	\$60,500,000	\$1,395,000	\$347,600	\$62,242,800	+ 9.5%
9. M. K. Ft. Lauderdale, FL	\$68,967,000	\$1,400,000	\$385,000	\$70,761,000	+24.4%

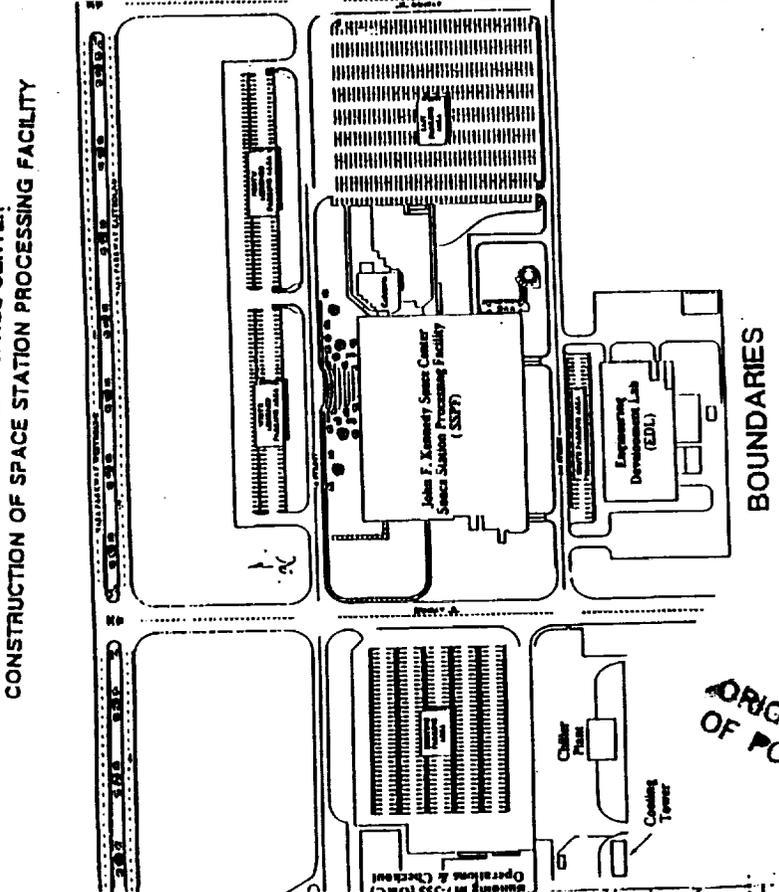
* Percent difference from the government estimate.

This was an excellent government estimate, since NASA's Policy is fair and reasonable cost estimates and for the government estimate not to be low. The SSPF government estimate splits the difference between the low bidder and the second low bidder (see Abstract of Bids). Comparison with the low bidder after awards at the pre-award conference showed the low bidder estimates were very close and government estimate on all major cost items, especially steel, mechanical, concrete, electrical, civil site work, etc., except the additive alternates. This was the best yet on the biggest KSC construction bid since the VAB bid January 7, 1964. A special NASA letter dated January 24, 1992, was sent out congratulating the KSC team: Engineering Development/Procurement Civil Servants, Jacobs Engineering Group, Inc., MacDonnell Douglas, Ralph Hahn and Associates, EG&G Vendors, sub contractors, etc. for their help with the excellent Government estimate. A special thank you to the Lead Design Engineer, Jose Perez-Morales, and Howell H. Row, Chief, Facilities Division and Joseph A. Brown, Lead Cost Engineer.

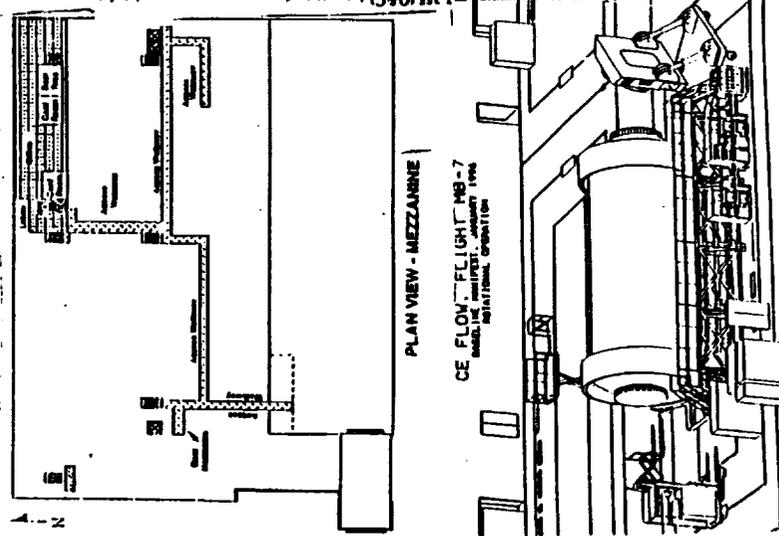
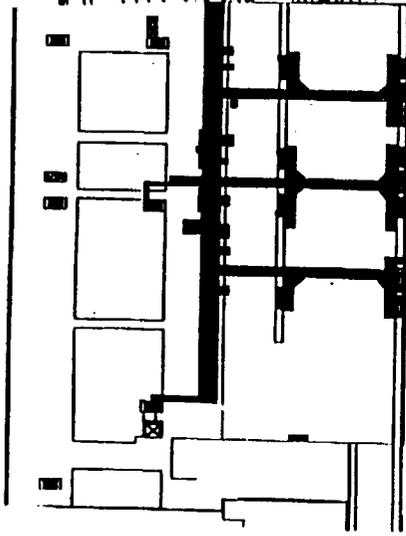
See plans, elevation and special features chart with the site plan and space module checkout platforms and SSPF System Summary, Pages 7 and 8.



JOHN F. KENNEDY SPACE CENTER
CONSTRUCTION OF SPACE STATION PROCESSING FACILITY



ORIGINAL PAGE IS
OF POOR QUALITY



SYSTEM SUMMARY OF GOVERNMENT ESTIMATE FOR BUILDINGS

DRAWING NO. 79K33032 - 20 SHTS, 79K33144 - 4 SHTS 82K00913 - 12 SHTS, 82K00914 - 11 SHTS, TOTAL 933 SHTS		PCN 93268		LOCATION KSC, INDUST. AREA, NASA CAUSEWAY, EAST OF O&C		PROJECT SPACE STATION PROCESSING FACILITY		
WORKORDER/CONTRACT NAS10-11800		ESTIMATOR P. GRUMBACH, JACOBS		VARDELL EG&G 832.1		CHECKER JONES, EG&G 832.1		
ARCH/ENGR JACOBS ENG. GROUP, NASA, JOE PEREZ DE-FED-32 667-3477		CONSTRUCTION COSTS		DURBIN, JACOBS		C-100		
SUBMITTED 07/790 S.S. 291		DESCRIPTION		BASIC P/LA		COMMENTS		
DIV. TITLE	QTY	UNIT	S/UNIT	S/BSE	TOTAL	DIV. TOTAL	SCOPE	
(2) SITE WORK	287,611	CY	13.61	8.39	3,915,129	340,264	1. FAIR A. SQUARE B. RECTAN C. V. SERV. D. REG. E. VERY F. ESPECIALLY J. PEREZ	
CLEAR & GRUB	41.4	ACR	2,046.38	0.18	84,720	340,264	EXCELLENT G.E. GREAT TEAM EFFORT CIV-SERV. ABLE & SUPPORT CONTR. THANK YOU VERY MUCH ESPECIALLY J. PEREZ	
DRAINAGE	8,297	LF	62.65	1.11	519,808	512,506	IRREGUL. & SOPHISTICATE FOR VOLUME. A&E WAS 66,608,008. DF-FED CUT EST 4% OFF PROFIT. 4% FOR VOLUME DISCOUNT	
EARTHWORK/FILL	222,552	CY	3.48	1.66	774,146	815,395	DESIGN DATA STEEL FRAME SIDING CAPACITY: 500' X 370' X 50' TO 74'-3PHI + RAMP STRUC. FRAME & STORAGE ADD 7,500 SF EXTERIOR WALL: METAL SIDING, FOAM CORE HEIGHT: 3 STORIES, 50' TO 74'-8" GROUND FLR AREA: 466,558 SF + RAMP & TUNNEL TOTAL FLR AREA: 466,558 SF + RAMP & TUNNEL 27,762 SF 438,025 CF	
EXC/BACKFILL TUNNEL	65,059	CY	5.89	0.82	383,418			
UTIL/PRELINE/PIPE	10,750	LF	63.72	1.47	684,953			
PAVING, 6163 TON	70,218	SY	18.40	2.77	1,291,919	678,160		
LANDSCAPE & FENCE	1,980	EA	88.97	0.38	176,165	137,235		
(3) CONCRETE	22,405	CY	235.04	11.29	5,265,996	471,598		
FORMWORK	229,101	SF	4.76	2.34	1,090,736	471,598		
REBAR	1,354	TON	1,092.87	3.17	1,479,745	11,881,321		
CONC & FILL	18,842	CY	84.96	3.43	1,600,759	111,421		
CEMENT DECK	3,663	CY	147.37	1.16	539,812	1,180,006		
EXP. JTS/ANCHORS/MSG	25,000	LF	22.20	1.19	554,944	916,024		
(4) MASONRY	47,018	SF	5.05	0.51	237,399	463,839		
(5) METALS	4,544	TON	2,155.02	20.99	9,792,395	6,698,948		
STRUCT STEEL	3,634	TON	2,160.45	16.83	7,851,078	1,132,763		
JOBTS	166	TON	1,630.14	0.58	270,603	2,224,231		
MSG	280	TON	3,582.99	2.15	1,003,236	154,089		
DECORNG (4387)	463,100	SF	1.36	1.35	628,150			
LADDERS & PLATE	361	LF	108.94	0.08	39,328	6,675,664		
(6) WOOD & PLASTICS	40	EA	589.65	0.05	23,586	770,799		
CABINET & COUNT. TOP	40	EA	589.65	0.05	23,586	240,046		
(7) MOISTURE PROTECT.	1,172,084	SF	2.33	5.84	2,726,373	315,736		
INS 6" BATT 2" RIGID	307,400	SF	1.12	0.74	345,234	2,359,422		
ROOF FLASHING D.S.	204,440	SF	2.14	0.94	438,566	116,866		
MET SIDING FOAM CORE	133,672	SF	8.76	2.51	1,170,822	288,905		
SPRAY ON FIRE PROT.	526,492	SF	0.94	1.07	496,928	1,081,530		
EXPANSION JOINTS	16,188	LF	16.98	0.59	274,823	1,172,700		
(8) DOORS & WINDOW	907	EA	1,659.79	3.23	1,505,428	323,774		
DOORS	369	EA	549.70	0.46	213,832	35,886		
VERTICAL DOORS	4,150	SF	119.09	1.06	494,243	4,070,393		
DOORS	884	EA	231.47	0.44	204,616	52,233,901		
WINDOWS	18,767	SF	13.70	0.55	257,157	353,824		
FINISH HOME	405	SETS	538.59	0.47	218,128	1,766,968		
STORE FRONT	407	SF	288.58	0.25	117,452	98,956		
(9) FINISHES	2,285,407	SF	1.75	8.57	4,000,454	55,237		
WALL SYS/SEAT BACK	474,320	SF	3.54	3.60	1,680,870	54,508,886		
FLOOR SYS.	336,239	SF	2.68	1.93	899,582			
CEILING SYSTEM	351,592	SF	2.44	1.84	856,233	1,735,898		
PAINT & COVER	1,123,252	SF	0.50	1.21	563,759	617,199		
*PROJECT TOTALS							56,861,983	

CONSTRUCTION BID DAT (FR10-0055-0)
 TOTAL BLDG. SP. 466,558 EXC. RAMP & TUNNELS 32,036,772
 ARCH/STRUC + R 88.67 / 785F 11,987,321
 INTERIOR MECH 28.37 / 785F 6,675,664
 INTERIOR ELEC 14.31 / 785F 1,987,321
 TOTAL INTERIOR 108.44 / 785F 30,593,757
 TOTAL EXTERIO 8.39 / 785F 3,915,129
 TOTAL CONSTR 116.83 / 785F 34,508,886
 ADD. I 3.72 / 785F 1,358,898
 ADD. II 1.32 / 785F 617,199
 TOTAL PROJ EST 121.88 / 785F 56,861,983
 BID DATE: 12/5/91 AWARD DATE: 2/15/91
 AWARDED TO: METRIC CONST. \$56,215,000
 CONSTRUCTION TIME SPARE 1,080 CALENDAR DAYS
 NO OF BIDDERS: 9 POS. OF GOV EST 2 OF 7
 PERCENT DIFFERENCE AWARDED BID & +1.4%
 NTP 4/16/91 SCHED. COMP. DATE 4/1/94
 COC
 BIDDERS BID AMOUNT
 METRIC CONST. 56,215,000
 GOV'T ESTIMATE 56,861,983
 W&J CONSTRUCTION 57,585,000
 BLOUNT BROS. CONST. 58,798,000
 CENTEX-ROONEY, INC. 59,170,000
 SOVRAN CONST., INC. 59,955,576
 CADELLE/HARDWAY 62,108,000
 WALSH CONST. 62,242,800
 MORRISON KNUDSON 70,761,000
 *INCLUDES CAFETERIA, VVG, TUNNEL & RAD ITEMS

HOW THE SSPF LOW BIDDER GOT LOW - CONSTRUCTION METHODS, ESTIMATING, BIDDING AND COMPUTERS

1. Used money saving systems - the Horizontal Dewatering System with direct burial, D/S Corrugated Plastic UG Piping System with special filters and pumps (to be used for future irrigation/sprinkler by NASA). Provided a clear and safe site, saves pulling out old weld point system.
2. Built prototype prefabricated forms for tunnels (1400 LF 25'x12'x14' +).
3. Used roadway vibrations roller compactor between piers - 700 c.y./day versus walk behind roller of 100 c.y./day.
4. Made building zone markers I - 24 and A - P. Site layout and work references, same as structural design drawings.
5. Planned to use Value Engineering (VE) proposals to increase profit.
6. Installed a satellite dish antenna receiving and transmitting at SSPF site for communication, payroll, labor reports, invoices, etc. Saved money over long line lease.
7. Computer estimating and bidding:
 - a. Used Timberline Computer Estimating System which is faster and better. It lets them bid and get more jobs.
 - b. Used Primavera Plan Schedule Computer System.
8. Metric's capability to do their own mechanical work in-house, which got them better sub bids.
9. Want to bid other KSC work, need more jobs.
10. Used process industry experience to get extra good quote from process industry.

BASED ON NUMBER OF BIDDERS* MEAN ACCURACY OF GOVERNMENT ESTIMATE

BASED ON OUR EXPERIENCE AND APPLICATIONS OF NUMBER OF BIDDERS CHARTS IT IS SUGGESTED THAT INCREASED BID COMPETITION LOWERS THE BID COST 7% TO 22% AS NUMBER OF BIDDERS INCREASES OVER 7 BIDDERS

<u>NO. OF BIDDERS</u>	<u>NO. OF PROJECTS</u>	<u>MEAN ACCURACY (%)</u>	<u>MEAN ABSOLUTE (%)</u>	<u>STANDARD DEVIATION</u>
2	1	4.53	4.53	0
3	4	- 3.24	9.70	11.20
4	10	- 1.73	11.77	15.21
5	10	- 7.02	18.19	24.66
6	11	- 8.51	13.41	14.80
7	6	- 27.86	27.86	20.01
8	9	- 20.72	20.72	28.65
9	8	- 20.93	23.33	28.26
10	1	- 5.41	5.41	0
11	2	- 12.42	15.09	21.33
13	2	- 13.81	18.93	26.76
15	1	- 22.66	22.66	0

FIGURE IV

* From Dr. R. M. Skitmore's Factors Affecting Accuracy of Engineering Estimating

HOW THE GOVERNMENT ESTIMATE FOR THE SPACE STATION PROCESSING FACILITY WAS SO ACCURATE

1. Team work effort between the NASA Lead Design Engineer, Design Engineers, Civil Servants and Lead Cost Engineer, etc., and the rest of the team which consisted of A&E's - Jacobs Engineering Group, Inc. and Ralph Hahn and Associates, Inc., McDonnell Douglas, Support Contractors - EG&G, Lockheed, McDonnell Douglas, Vendors, Suppliers and Sub Contractors

2. Lots of cost estimating over 15 separate estimates, since 1983 from many concepts, budgets, PER, Preliminary 30, 60, 90, 95 and Detail C100 - Final Government Estimate

3. Vendors, suppliers and sub contractors - budget quotes for estimating over 400 quotes

4. KSC Cost Engineering System - Cost Data

- o Estimating Specifications - G0002 and G0003
- o Cost Index 1974 - Present
- o Special Cost Engineering Summaries - L&M, System, Budget Comparison
- o 3 Volume Price Books
- o 17 Other KSC Cost Estimating Tools (see Aerospace Construction Cost Estimating Technical Paper, 1st World Cost Engineering Congress, July 1, 1992
- o Continuous Developing and Testing New Estimating Tools such as Fiber Optics and Pneumatic Panels (see Chart 8 - New Exciting Tools).

5. High Bid/Medium Bid/Low Bid Analysis - See part II of Budget Comparison Summary

6. Bidder Analysis based on number kind and type of potential bidders:

a. Source list of bidders that got the SSPF Plans, Specifications and IFB (over 945 Bidders)

b. Pre Bid Conference - 14 page list of bidders

c. A Survey of local Print Shops - Full Size Drawing Requests at \$580 a set, list of bidders getting drawings.

d. Questions from bidders, prime and subs, etc. - 725 questions from bidders including - 10 Primes

e. Dodge Report list of 10 primes receiving sub bids

f. Open Shop versus Closed Shop

g. Accuracy of government estimates based on 900 bid projects over 6,000 bidders. Low bidders averaged 8.4% under the government estimate at KSC. High bidders averaged 32% over the government estimate.

h. Accuracy of government estimates based on number of bidders (University of Salford Study)

i. Construction Market condition at bid opening

7. Computer Analysis - what if - overhead, profit, volume discounts by Lead Design Engineer and Lead Cost Engineer (PAGE 27)

8. Lots of extras, good hard detailed estimates and analysis, work by team

9. Planed and scheduled analysis based on limited three (3) year funding - construction etc.

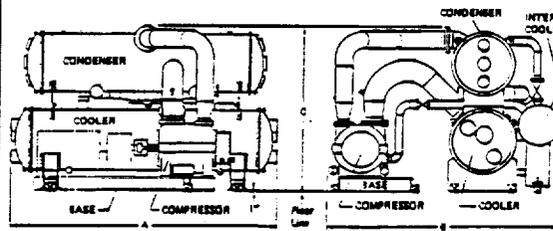
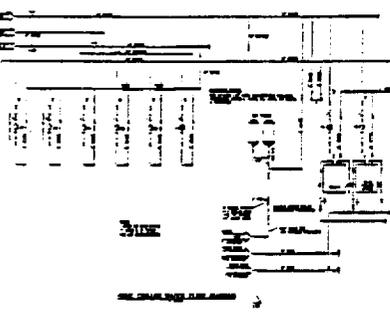
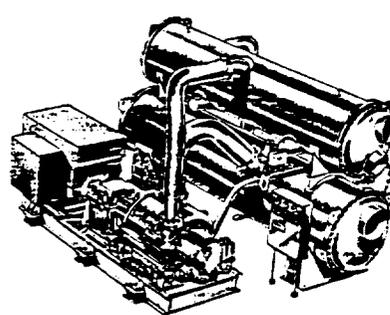
10. Management policy was to get the best and most accurate government estimate possible
11. Cost trend analysis throughout design
12. Excellent detail labor and material quantity take off, correct quantities with very good unit prices.
13. Fine tuning PT&I rates especially civil, mechanical, and electrical.
14. Accurate estimates for design changes throughout design
15. Managements strong support to allow internal technical cost expertise to influence and override independent A&E cost estimates

ENERGY COST SAVING

See System Summary of additive alternates for the 2,500 ton chiller. This summary was used in the submittal to Florida Power and Light for energy cost saving credit of \$350,000. The central chilled water distribution system for the KSC Industrial Area with additional energy cost savings is estimated at over \$150,000 per year, plus increased efficiency and operation cost. Based on a 25 year life cycle and the present worth comparison this system will save more than \$5 million.

1-23-91

SYSTEM SUMMARY OF GOVERNMENT ESTIMATE FOR BUILDING										SHEET 2 OF 12	
DRAWING NO. 79132718										232	
PROJECT SECOND BWP 2,500 TON CHILLER											
JOB NO. 0806 CONTRACTOR ARCHITECT ENGINEER										TASK VI	
ESTIMATOR JONES, ERIC A32.1										SUBTITLE - ALTERNATIVE	
CHECKER J. J. BURBANK / 0806										CODE C-100	
SUBMITTED 10/13/90										SUBMITTED 10/13/90	
CONSTRUCTION COSTS										DESCRIPTION	
QTY	TITLE	UNIT	1/UNIT	1/TON	TOTAL	DIV.	TOTAL			QUANTITY	
2,500	IS. MECHANICAL	TON	547.58	547.58	1,368,940					COSTS	
2	EQUIP. TO INSTALL	EA	3,123.50	3.20	6,247		1,375,187			COSTS	
2,500	CHILLER R-22	TON	56.34	56.34	140,850		1,516,037			COSTS	
2,500	LAMPS	TON	57.18	57.18	142,950		1,658,987			COSTS	
2,500	MATERIALS	TON	54.93	54.93	137,325		1,796,312			COSTS	
2	PUMP RECIRCULATION	EA	56,643	28.32	113,286		1,909,598			COSTS	
254	PIPE SCH 40 8" - 30"	LF	108.33	0.81	20,515		1,930,113			COSTS	
24	FLANGE 81/2" 150 8" - 30"	EA	501.24	3.18	76,116		2,006,229			COSTS	
15	ELBOW 8" - 30"	EA	154.77	2.73	4,106		2,010,335			COSTS	
1	WELDER	EA	108.00	0.24	108		2,010,443			COSTS	
5	WELDER	EA	376.40	1.11	5,646		2,016,089			COSTS	
10	CONTR/CHECK VALVE 8" - 30"	EA	246.10	3.78	3,781		2,019,870			COSTS	
1	FLM MIXER	EA	5,446.00	3.20	5,446		2,025,316			COSTS	
1	TRIP. 4" 1/2" ELBOW	EA	174.25	3.21	547		2,025,863			COSTS	
11	OUTSIDE PIPING & FITTINGS	LF	286.65	10.22	28,539		2,054,402			COSTS	
2	BLIND FLANGE 24"	EA	1,716.00	1.37	2,828		2,057,230			COSTS	
2	ELBOW 20"	EA	188.50	3.79	7,618		2,064,848			COSTS	
20	IS. ELECTRICAL	PTS	733.73	3.69	73,746		2,138,594			COSTS	
2	COM PUMP	PTS	140.00	0.56	1,120		2,139,714			COSTS	
2	COM DISTRIB. PUMP	PTS	140.00	1.25	2,500		2,142,214			COSTS	
1	CHILLER	PTS	63.67	3.08	3,104		2,145,318			COSTS	
2,500	TOTAL SYSTEMS	TON	552.44	552.44	1,375,187		2,145,318			COSTS	
COST IN BRACKETS ARE SUB-TOTALS										CONSTRUCTION BID DATA (1981-0000-0)	
										ARCH. LF 2,500	
										ELEC. LF 2,500	
										TOTAL PROJECT 2,145,318	
										NO DATE 1-23-91	
										AWARDED TO 2-13-91	
										CONSTRUCTION TIME SHIP 1-23-91	
										NO OF BIDDERS 1	
										PERCENT DIFFERENCE AWARDED BID 1.1%	
										BIDDER	
										METRIC CONST. 1,150,000	
										BOW Y ESTIMATE (ADJUSTED) 1,383,633	
										HALF CONSTRUCTION 1,300,000	
										BLIGHT BROS. CONST. 1,000,000	
										CENTEX-RODNEY 216,000	
										BOWERS CONST., INC. 283,223	
										CARROLL HARDENBY 215,000	
										WILSH CONST. 393,200	
										HARRISON HANSON 1,000,000	
										BOW Y ESTIMATE (ORIGINAL) 1,735,496	



SUMMARY

The accuracy of the SSPF estimate proves the benefits of our Kennedy Space Center (KSC) teamwork efforts and KSC Cost Engineer Tools which are contributing toward our goals of the Space Station.

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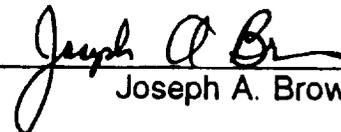
March 3, 1993

New Exciting Estimating Tools

As a part of DE cost engineering continuous improvements, some new exciting aerospace construction and GSE cost estimating tools are being developed and tested at KSC:

1. Fiber Optics Cable - Cost per fiber foot/meter - John Shramko and Bob Lupo/DF-FED-22, Joseph A. Brown/DF-FED, Lashanda Gantt/DF-FED-2, Austin Durette/EG&G (Page 1B).
2. Cost Per Panel Component Chart - Labor, Material & Fabrication - For Budget and Cross checking - Etheroy Jones/EG&G, Joseph A. Brown/DF-FED (Page 1C).
3. Chart - Cost Per Panel Component Only - Kim Ballard/DM-MED-42 (Page 1D).
4. CAD/Automatic Cost Estimating - Joseph a Brown/DF-FED, Hank Perkins/DL-DSD-22.
5. Work Hours Per Panel Component Chart and Summary Analysis - Joseph A. Brown/DF-FED, Etheroy Jones/EG&G (Page 1E).
6. Chart for Detail Estimating Pneumatic and Hydraulic Panels and Tubing - Work Hours and Materials - Etheroy Jones/EG&G, S. Thomason/PRC, Joseph A. Brown/DF-FED (Page 1F).
7. Work Hours for Welding SS Tubing-Astro Heliarc Welding Machine - Etheroy Jones/EG&G, Joseph A. Brown/DF-FED (Page 1G).
8. OFE/GFE Estimating Cost for Handling, Storage, and Insurance, 1-10% - Joseph A. Brown/DF-FED.

FROM:



Joseph A. Brown

ORGANIZATION: DF-FED

EXT: 7-3268

1A

PAGE 17

GROUND SUPPORT EQUIPMENT

COST ESTIMATE

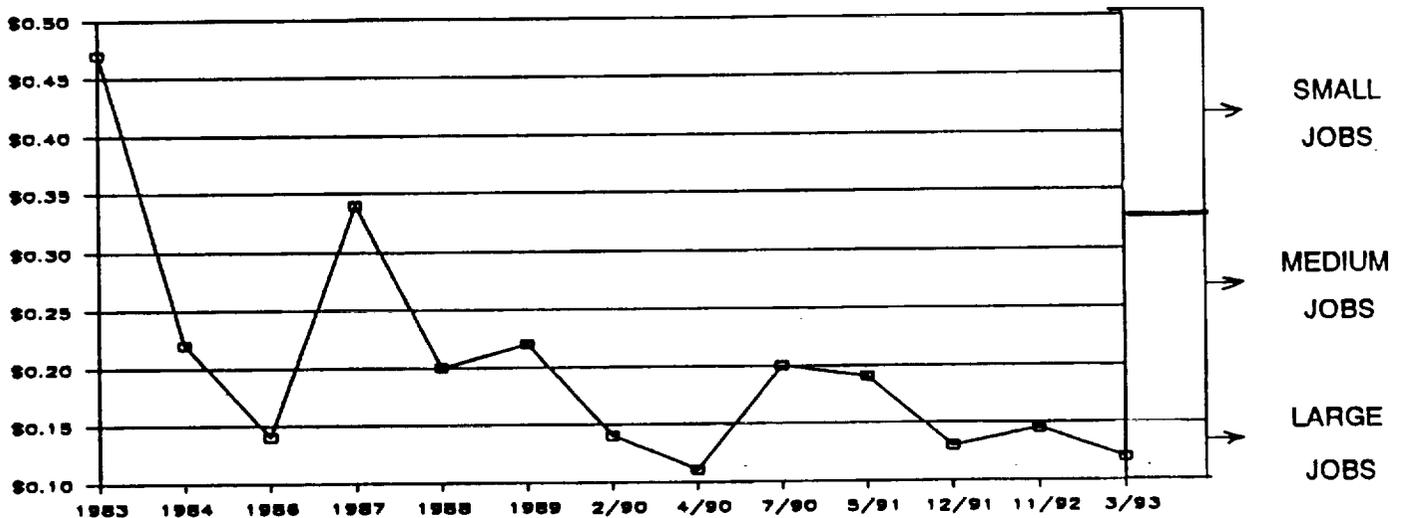
CONSTRUCTION

CODE PRICE BOOK	DATE COMPLETED 3/16/93	SHEET SHEET	OF OF
PROJECT/W.O. TITLE UNIT COST FIBER OPTIC CABLE (Per Fiber Foot)		DRAWING NO(S)	SHEET # 16906-8
STATION SET	LOCATION KENNEDY SPACE CENTER	PCN	SPECSINTACT 16906
ESTIMATOR L.A. DURETTE, EG&G 832.1	CHECKER C. PIERCE, EG&G 832.1	APPROVED JOE BROWN, DF-FED	

THE FOLLOWING GRAPH IS BASED ON INFORMATION TAKEN FROM AWARD AMOUNTS FOR CONTRACTS COMPLETE FROM 1980 THRU 1991 WITH FIBER COUNTS OF 10, 30, 36, 72 & 144 FIBERS BOTH SM & MM SM = Single Mode, MM = Multi Mode IN NON-PRESSURIZED & PRESSURIZED AND GELL FILLED CABLE SYSTEMS AND TESTED AT THE FOLLOWING WINDOWS Test 1. 850/1300 Test 2. 1550 um WINDOWS. ** ALL NEW SYSTEMS ARE BEING TESTED AT 1300 & 1500 WINDOWS **

CONTRACT #	DATE BID	AWARD AMOUNT	TOTAL FIBER FT.	COST PER FF	CABLE SIZE
11026	12/83	* 148,230 *	317,500	\$0.47	10 PRESS
IFB 10-0113-4 SUPPLY CONTRACT ONLY 9/84 463,302 2,105,918 \$0.22 30 PRESS					
11329	1/86	1,043,261	7,262,100	\$0.14	36 & 72
11445	9/87	303,168	889,308	\$0.34	36 & 72
11510	3/88	745,225	3,728,808	\$0.20	72
11587	3/89	340,937	1,568,124	\$0.22	36 & 72
11682	2/90	1,836,781	13,102,344	\$0.14	72 & 144
11705	4/90	689,625	6,218,244	\$0.11	36 72 & 144
11725	7/90	534,000	2,635,072	\$0.20	36 72 & 144
11834	5/91	889,557	4,756,680	\$0.19	36 72 & 144
11891	12/91	1,249,990A	9,786,420	\$0.13	36 72 & 144
11970	11/92	1,473,935A	7,424,220	\$0.145	36 72 & 144
1200E	3/93	867,677A	7,274,400	\$0.1193	72 144 & 216

FIBER FOOT COST GRAPH



SUMMARY ANALYSIS: AWARD AMOUNTS WITH THE LETTER A, INDICATE COST ADJUSTED FOR FIBER ONLY.
SMALL JOBS LESS THAN ONE (1) MILLION FIBER FEET COST BETWEEN \$.34 - \$.50 PER FIBER FOOT
MEDIUM JOBS 1.5 - TO 4 MILLION FIBER FEET COST BETWEEN \$.19 - \$.22 PER FIBER FOOT.
LARGE JOBS 5 MILLION & OVER FIBER FEET COST BETWEEN \$.11 - \$.155 PER FIBER FOOT.
SUMMATION: DUE TO ECONOMY OF SCALE, LARGER JOBS ARE MORE COST EFFECTIVE.

DIRECT BURIED / PLOWED, APPEARS TO COST APPROXIMATELY THE SAME AS, OR LESS THAN CABLE PULLED IN DUCT BANK IN INNERDUCT.

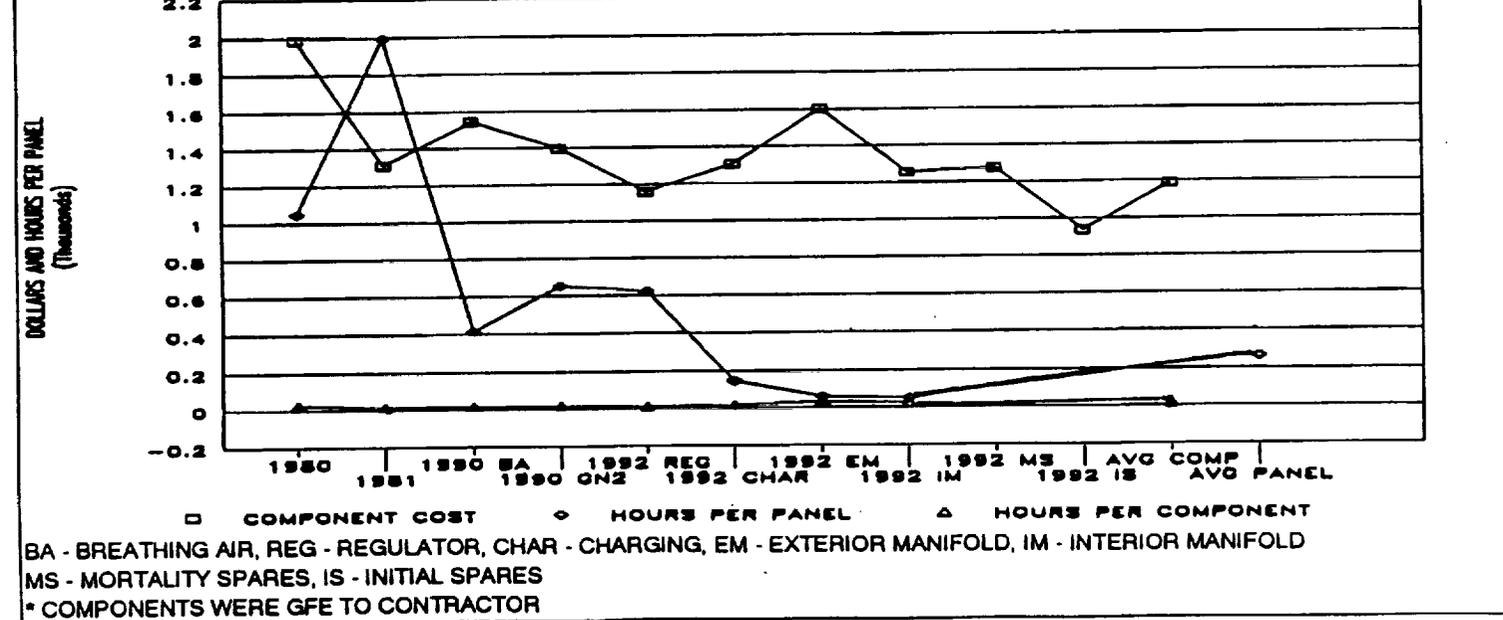
[] GROUND SUPPORT EQUIPMENT		COST ESTIMATE		[] CONSTRUCTION	
CODE		DATE COMPLETED		SHEET 15100-25	
PRICE BOOK		1-15-93			
PROJECT/W.O. TITLE				DRAWING NO(S)	
BROWN, JONES, BALLARD COST PER COMPONENT CHART					
STATION SET		LOCATION		PCN	
		KENNEDY SPACE CENTER			
ARCHITECT OR ENGINEER				WORK ORDER OR CONTRACT NO.	
EG&G					
ESTIMATOR		CHECKER		APPROVED	
E. JONES, EG&G 832.1		VARNDELL, EG&G 832.1			

B J B C P C C THE GRAPH IS BASED ON COMPONENTS TAKEN FROM GOVERNMENT ESTIMATES.

CONTRACT #	BID DATE	NAME OF PANEL	GOV. EST.	NO. OF COMP.	COST PER COMP.	MHRS PER COMP.	MHRS PER PANEL	LOW BIDDER COST	REMARKS
IFB-10-0124-0	10-28-80	GN2 ECLSS SERVICE	71,521	36	1,987	29	1,049	66,267	ELECTRICAL
IFB 10-0045-1	3-11-81	MMH PRESS. PURGE	201,626	154	1,309	13	** 1,992	175,349	**ADJUSTED
NAS10-11711	5-8-90	BREATHING AIR (3 EA)	(106,555) 48,825	* 69	1,544 708	18	1,243	28,379	
NAS10-11711	5-8-90	GN2 PANEL	(47,490) 23,705	* 34	1,397 697	19	653	26,512	
NAS10-11949	9-14-92	REGULATOR PANEL	60,187	52	1,157	12	623	54,483	BREATHING AIR
NAS10-11949	9-14-92	CHARGING PANEL	11,751	9	1,306	16	145	13,189	IS REGULATED
NAS10-11949	9-14-92	EXT. MANIFOLD (3 EA)	9,603	6	1,601	31	185	8,070	FRM 2,400 PSIG
NAS10-11949	9-14-92	INT. MANIFOLD (9 EA)	22,608	18	1,256	25	446	21,510	TO 60 PSIG
NAS10-11949	9-14-92	TEST MANIFOLD (6 EA)	5,778				125	6,720	
NAS10-11949	9-14-92	MORTALITY SPARES	35,710	28	1,275			4,613	MATERIAL ONLY
NAS10-11949	9-14-92	INITIAL SPARES	32,799	35	937			39,637	MATERIAL ONLY
	TOTALS	(26 PANELS)	524,113	441		15	6,461		
AVERAGE COST PER PANEL & COMPONENT			20,158		1,188				
AVERAGE COMPONENT & MHRS PER PANEL				17		15	249		

COMPONENTS ARE: VALVE, FILTER, GAUGE, SWITCH, TRANSDUCER, ORIFICE AND SILENCER
 TUBING AND KC FITTINGS ARE GFE TO THE CONTRACTORS - NOT ADJUSTED FOR ESCALATION

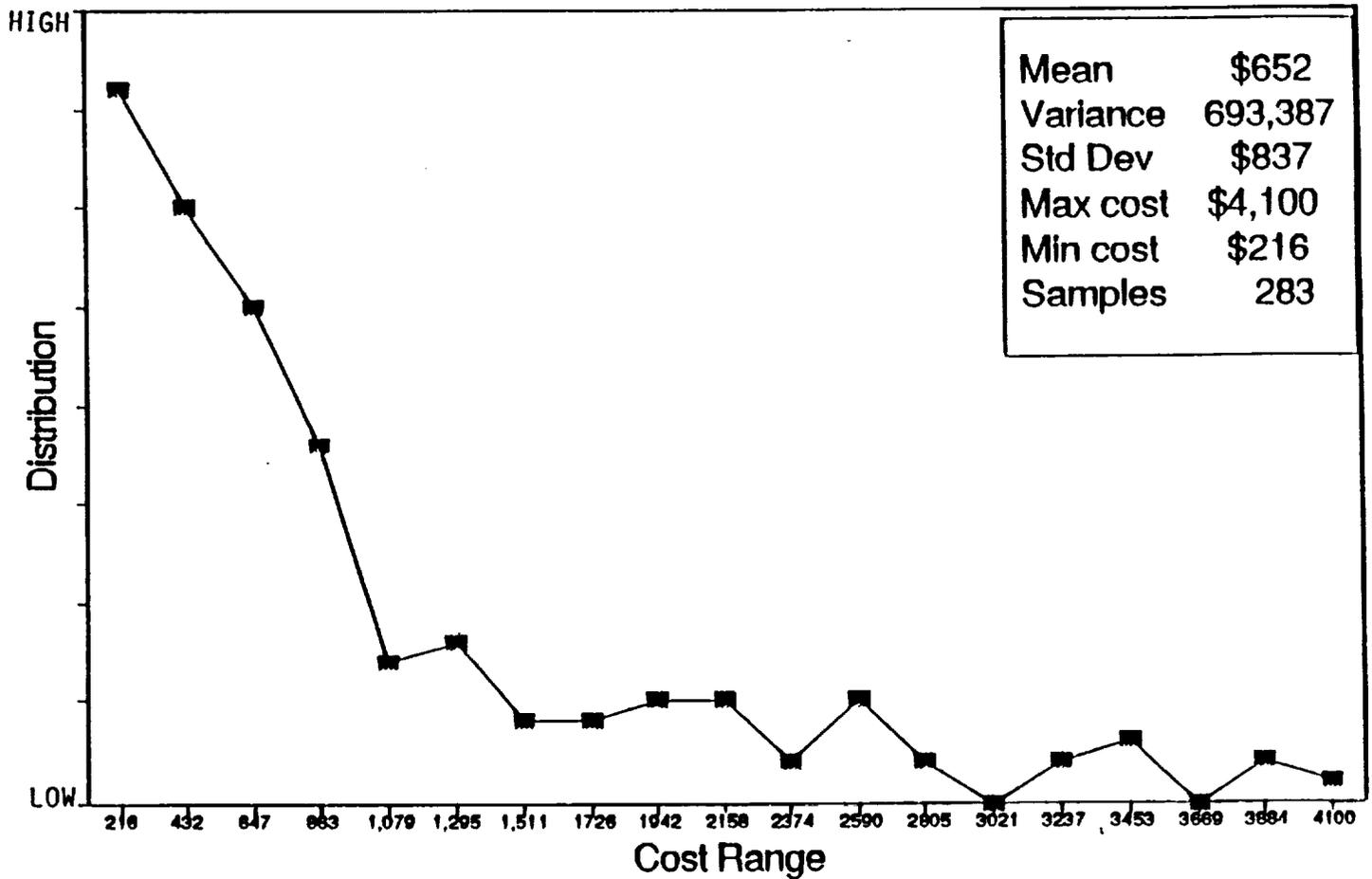
COST PER COMPONENT, HOURS PER PANEL
AND HOURS PER COMPONENT GRAPH



MATERIAL ONLY, FROM MDSSC KIMS

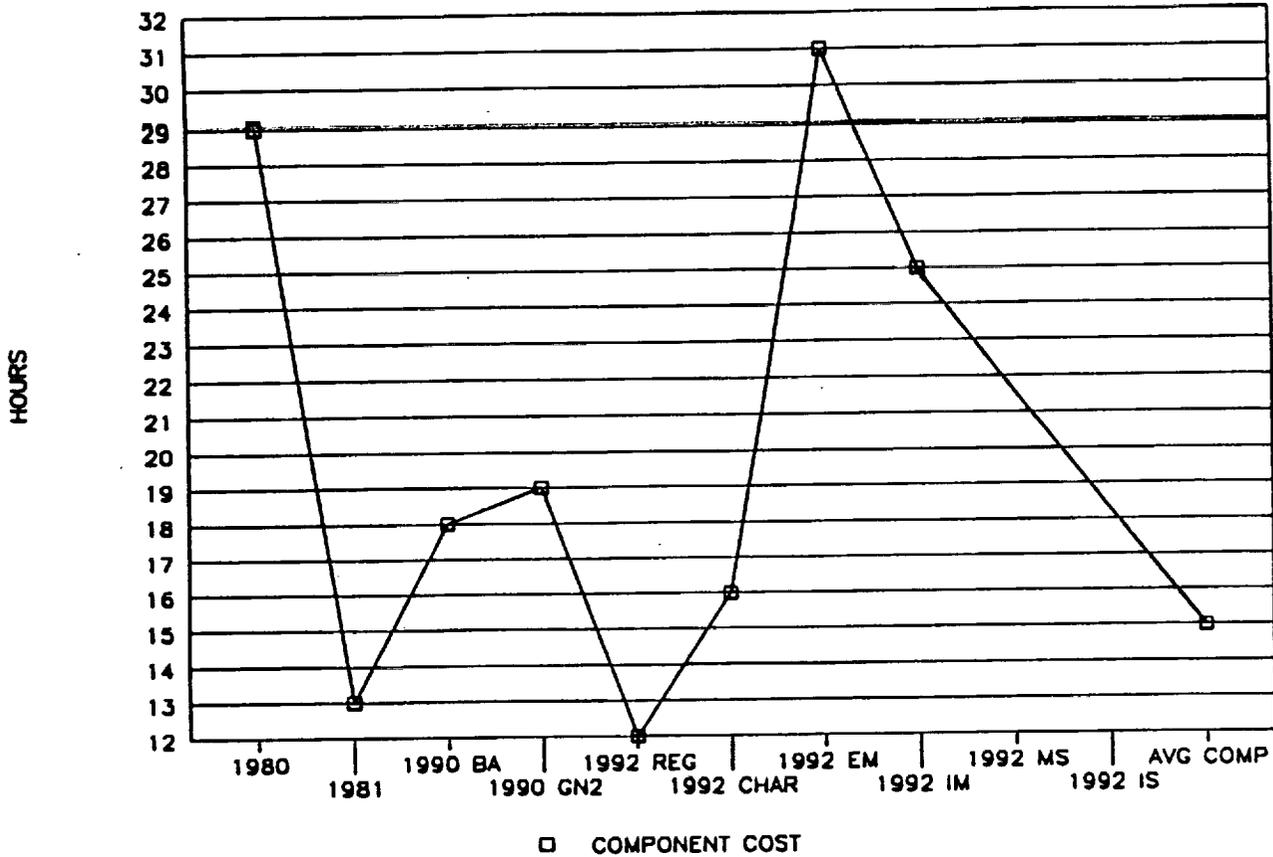
FLUID COMPONENTS: Valve, Filter, Gage, Switch, Transducer, Orifice and Silencer

Pneumatic Panel Component Cost Distribution



Per Kim Ballard MD-MED-42
Telephone No. 867-3266
Date Nov. 19, 1992

HOURS PER COMPONENT



SUMMARY - ANALYSIS OF PNEUMATIC PANEL COST

1. Average cost per component is \$937 to \$1,987; to be used for budget estimate and cross check detail estimate.
2. Concerning escalation 1980-1992; little or no escalation. May have gone down slightly due to learning curves, experience, material cost flat or decreasing.
3. Electrical/Mechanical type panel cost more than mechanical panel only.
4. Be aware of GFE component cost as they affect average panel.
5. Tubing and KC Fittings are assumed GFE in all cases.
6. Budget estimating cost for panel is \$10,000 through \$360,000; still being evaluated.
7. Increase size of tubing, fittings and component will cost more; normal size 1/4" to 1" with few 1-1/2" and 2".
8. Panels are fabricated, tested, and cleaned in the shop and delivered to KSC, no bond or sales tax.

REVISED 4-23-92 ^{4/8/93}

SPECSINTACT. 15066

ESTIMATING MANHOURS FOR STAINLESS STEEL TUBING
PNEUMTIC AND HYDRAULIC PANELS & LONG TUBING RUNS

\$24.35

MANHOURS SHOP RATE FOR PANELS - \$20-\$25/HR--MANHOURS FIELD RATE FOR LONG RUN - \$23.85/HR

KC FITTINGS				
KC106 - Reducer		KC130 - Plug		
KC150 - Cap		KC112 - Nipple		
KC115 - Bushing		KC142 - Nut		
KC143 - Sleeve		KC164 - Bushing		

PANELS & LONG RUNS*				
SIZE	ABOVE ELBOW		TEE	
	KC FITT.	UNION NIPPLE VALVE	HR/EA	CROSS
C4 = 1/4"	.12	.24	.48-	.96 .36
C6 = 3/8"	.14	.28	.56-1.12	.42
C8 = 1/2"	.16	.32	.64-1.28	.48
C12 = 3/4"	.21	.42	.84-1.68	.63
C16 = 1"	.25	.50	1.00-2.00	.75
C20 = 1-1/4"	.30	.60	1.20-2.40	.90
C24 = 1-1/2"	.35	.70	1.40-2.80	1.05
C32 = 2-"	.44	.88	1.76-3.52	1.32

*On Long Runs, Labor may be cut in half (less handling).

Butt welded tube fitting tube assembly, see "Herkirmer" p. 79, Table 54 - E11 & tees - Schedule 10, use one half labor manhour units, plus fitting & extra testing. For Butt welded tube fitting only, use table as is.

KSC-SPEC-Z-007 STAINLESS STEEL TUBING FLARING, FIT CHECK, CUTTING, BENDING			
SIZE	WALL THICK	TUBE	TUBE-LONG
		ASSY*	RUN PLUS SPEC FITTINGS
		HR/EA	HR/LF
1/4	.035"	2.32	.09
3/8	.035"	2.78	.12
1/2	.049"	3.40	.14
3/4	.065"	4.40	.18
1-	.095"	5.48	.23
1-1/4	.049"	6.56	.28
1-1/2	.049"	7.64	.32
2-	.065"	8.88	.37

*Includes Labor for two nuts and two sleeves

Add for cleaning - KSC-SPEC-123 - Levels 100, 200, 300, Visual Clean; hangars; Supports; Testing; Electrical Cables & Distribution; Checkout; Validation; Current Material Prices.

Face Plate A-36 Fabricate Panel Face Plate and Bracketry Labor: Use .12 TO .22 HR/LB.

Framing steel A-36 Support Frame Steel: Use .07 HR/LB.

Paint steel: Use .02 to .05 HR/SF, 15 to 25 CENT/SF

SIZE	LOCK NUTS	2/11/92 **MAT. COST
1/4"	AN924-4K	\$.85
3/8"	AN924-6K	.95
1/2"	AN924-8K	1.75
3/4"	AN924-12K	2.85
1-"	AN924-16K	4.10
1-1/4"	AN924-20K	15.00
1-1/2"	AN924-24K	17.00
2-"	AN924-32K	32.50

**Mat. Cost Based on Quan. 100

Panels Accessory Labor & Material			
	LAB/HR	UNIT	MAT.
Panel Label	.50	ea	\$.30
Ident. Plate Plastic	.50	ea	.20
Band Marker 75M04185*	.10	ea	.40
Coat Tubing w/AR-7	.05	lf	.12
Corrosive Protection			
Clean Tube Assy-Level 300	1.00	ea	4.00
Clean Component-Level 300	1 to 3	ea	4.00
Color Code	.03	lf	.04
75M02048-1-Bleed Fitting 3/8"	.14	ea	\$175.25
79K80456-Supersedes 75M02048-1			
Leak Test Panel 15 hr ea			
*For Each Tube Assembly			

See Panels Section 13F in Aerospace Price Book for Sample. Adjusted for Aerospace Quality, Tolerance, Cleaning & Testing, etc. Reference "Herkirmer" - Cost Manual for Piping Mechanical Construction. Tables 66 & 68, pp. 93 & 9

ESTIMATOR: Elroy Jones Jr.

CHECKER: [Signature]

5066

SPECSINTACT 15066-1A

ESTIMATING MANHOURS FOR WELDING STAINLESS STEEL TUBING AND FITTINGS USING ASTRO HELIARC WELDING MACHINE

BUTT-WELD TUBING PER JOINTS AND FITTINGS IN MANHOURS

SIZE	TUBING JOINT			ELBOW	TEE	CROSS
	HANDLING	WELD	TOTAL			
1/4"	0.40	0.02	0.42	0.63	0.98	1.33
3/8"	0.41	0.02	0.43	0.65	1.00	1.35
1/2"	0.49	0.03	0.52	0.84	1.34	1.84
3/4"	0.57	0.03	0.60	0.87	1.39	1.91
1"	0.64	0.04	0.68	0.98	1.45	1.96
1-1/4"	0.72	0.05	0.77	1.14	1.64	2.14
1-1/2"	0.80	0.06	0.86	1.29	1.90	2.51
2"	0.92	0.10	1.02	1.53	2.20	2.87

LABOR HOURS ARE AVERAGED FROM HERBERT HERKIMER COST MANUAL 1958 PAGES 77 AND 79, TABLES 52 AND 54, 1/2 THE LABOR FOR SCHEDULE 10 OF STAINLESS STEEL BUTT-WELD PIPE AND FITTINGS, MEANS MECHANICAL COST DATA 1991 SCHEDULE 5 ON PAGES 78, 79 AND 80 AND ASTRO ARC SYSTEM OF PAGE 30B

BUTT-WELD TUBING PER LINEAL FEET AVERAGE TWO WELDS PER 20 FEET WITH MARK-UPS OF \$24.00 HOURS, 26% P.T.&J., 15% OVERHEAD, 10% PROFIT, 10% PRIME MARK-UP AND 1% BOND.

SIZE	LF	WELD-LF	TOTAL (MH)	MARK-UP (\$)
1/4"	0.16	0.04	0.20	X MARK-UPS = 8.50 LF
3/8"	0.16	0.04	0.20	X MARK-UPS = 8.50 LF
1/2"	0.19	0.05	0.24	X MARK-UPS = 10.20 LF
3/4"	0.21	0.06	0.27	X MARK-UPS = 11.47 LF
1"	0.24	0.07	0.31	X MARK-UPS = 13.17 LF
1-1/4"	0.27	0.08	0.35	X MARK-UPS = 14.87 LF
1-1/2"	0.29	0.09	0.38	X MARK-UPS = 16.15 LF
2"	0.36	0.10	0.46	X MARK-UPS = 19.55 LF

LABOR HOURS ARE AVERAGED FROM HERBERT HERKIMER COST MANUAL 1958 PAGE 75, TABLE 50, SCHEDULE 5 AND MEANS MECHANICAL COST DATA 1991 SCHEDULE 5 ON PAGE 75. ADD PRICE FOR TUBING.



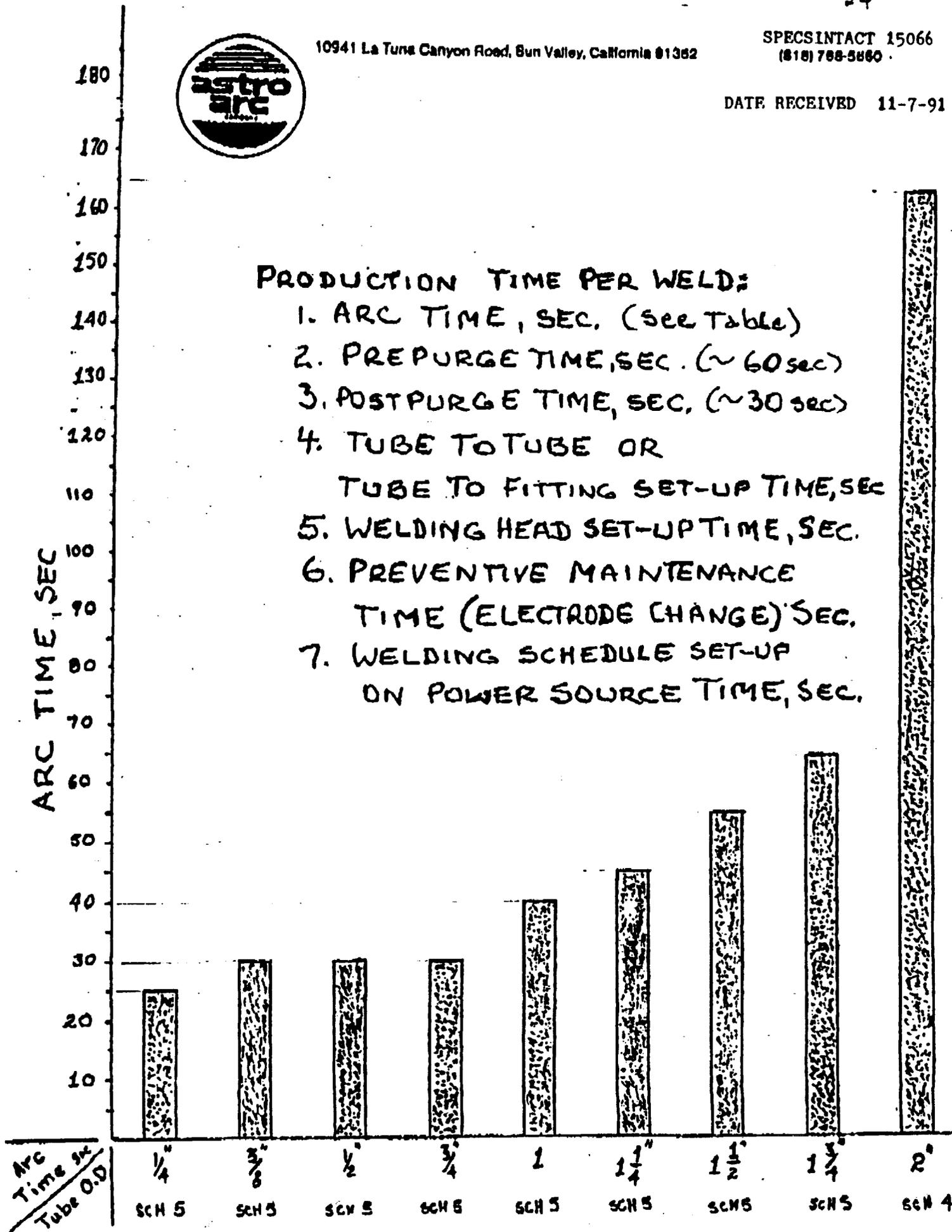
10941 La Tuna Canyon Road, Sun Valley, California 91352

SPECSINTACT 15066
(818) 768-5860

DATE RECEIVED 11-7-91

PRODUCTION TIME PER WELD:

1. ARC TIME, SEC. (see Table)
2. PREPURGE TIME, SEC. (~ 60 sec)
3. POSTPURGE TIME, SEC. (~ 30 sec)
4. TUBE TO TUBE OR
TUBE TO FITTING SET-UP TIME, SEC
5. WELDING HEAD SET-UP TIME, SEC.
6. PREVENTIVE MAINTENANCE
TIME (ELECTRODE CHANGE) SEC.
7. WELDING SCHEDULE SET-UP
ON POWER SOURCE TIME, SEC.



SYSTEM SUMMARY OF GOVERNMENT ESTIMATE FOR BUILDINGS

9-14-92 SHEET 1 OF 2 308

DRAWING NO. 82K03283, 82K03286	SHEETS 13, 6 & 5	PCN 96275.1	LOCATION KSC
WORK ORDER/CONTRACT NAS10-11949	ARCH/ENG. LDE: M. HOGUE 7-2759	ESTIMATOR E. JONES, EG&G 932.1	CHECKER R. VARINDELL EG&G 832.1
PROJECT PS1F-R BREATHING AIR DISTRIBUTION, SY 14 PANELS AND SPARES		SUBMITTED 9-14-92 5.5. 11-11-92	

QTY	UNIT	\$ UNIT	\$/LF	GFE TOTAL	TOTAL WITH GFE	PANEL TOTAL	DIV. TITLE	QTY	UNIT	\$ UNIT	\$/LF	GFE TOTAL	TOTAL WITH GFE	PANEL TOTAL
81	LF					60,187	CLEAN TUBE ASSY/COMP.	5	EA	41.40	34.50			
561	LB	3.91	27.06	2,192	11,410		TEST MANIFOLD	1	EA	58.00	9.67			
6	EA	1,426.25	140.86	23,332	5,725		GFE FACTORS 3%							
36	EA	648.11	288.05	5,725	1,329		FREIGHT							
2	EA	2862.50	70.68	1,329	5,947		MANIFOLD 82K03286-2	5	LF	9 @				22,608
6	EA	221.50	16.41	5,947	3,563		PLATE & FRAME	23	LB	6.17	28.40			
59	EA	88.63	64.56	718	2,708		1-1/4" PIPE/WELD BOSS	5	EA	123.00	123.00			
306	EA	6.09	23.01	1,699	1,009		TUBE ASSY, 1/4"	3	EA	67.33	40.40			
227	EA	11.93	33.43	2,708	4,978		KC FITTINGS	23	EA	5.91	27.20			
355	EA	2.84	12.46	1,009	231		SHUT-OFF VALVE 1/4"	1	EA	391.00	78.20			
105	EA	47.41	61.46	4,978	235		PRESSURE GAUGE	1	EA	214.00	42.80			
1	EA	231.00	2.85	2,417	80		Q/D/ SOCKET & CAP	8	EA	20.00	32.00			
				80	100		MISC. HARDWARE	50	EA	2.88	28.80			
				100	711		IDENT. TAG/LABEL/PLATE	18	EA	12.28	44.20			
30	LF			711	235		CLEAN TUBE ASSY/COMP.	4	EA	43.50	34.80			
172	LB	4.13	23.70	235	1,886		TEST MANIFOLD	1	EA	58.00	11.60			
8	EA	884.75	235.93	7,078	822		GFE FACTORS 3%							
1	EA	235.00	7.83	235	374		FREIGHT							
11	EA	109.18	40.03	185	448		MANIFOLD 82K03286-3	2	LF	6 @				5,778
69	EA	6.49	14.93	374	521		1-1/4" PIPE/WELD BOSS	4	EA	123.75	247.50			
43	EA	12.12	17.37	521	404		Q.D. SOCKET & CAP	8	EA	20.00	80.00			
137	EA	2.95	13.47	404	917		KC FITTINGS	8	EA	8.25	33.00			
19	EA	48.26	30.57	917	116		IDENT. TAG/LABEL/PLATE	7	EA	13.29	46.50			
1	EA	116.00	3.87	559	20		MISC. HARDWARE	8	EA	3.75	15.00			
				559	100		CLEAN MANIFOLD	1	EA	63.00	31.50			
				100	3,201		TEST MANIFOLD	1	EA	29.00	14.50			
6	LF	3 @		3,201	175		GFE FACTOR 3%							
28	LB	6.25	29.17	175	370		FREIGHT							
1	EA	370.00	61.67	370	615		MORTALITY SPARES	28	EA	1,275.36	VALVES, REGUL. FILTERS, GAUGE			35,710
5	EA	123.00	102.50	615	361		INITIAL SPARES	35	EA	937.11	VALVES, REGUL. FILTERS, GAUGE			32,799
4	EA	90.25	60.17	361	127		TOTAL SYSTEMS	186	LF	959.33	959.33			178,436
26	EA	6.00	26.00	127	391		SEE SHEET 2 OF 2 FOR PICTURES OF PANELS AND MANIFOLDS ASSY.							
1	EA	391.00	65.17	391	214									
1	EA	214.00	35.67	214	160									
8	EA	20.00	26.67	160	217									
74	EA	2.93	36.17	217	221									
16	EA	12.28	36.83	221										

COMMENTS: FED CUT MSSC EST. FROM \$304,701; MANIFOLD & MORT. SPARES TOO HIGH \$50,000. \$255,007 RECEIVED AFTER BID OPENING TOO LATE TO USE.

DESIGN DATA: TYP. FAC: BREATHING AIR PANELS & MANIFOLDS STRUCT. FRAME: CARBON STEEL A-36 SPECIAL FEATURES: THESE PANELS ARE NOT ELECTRICAL CONTROL. PNEUMATIC FUNCTION 2,400 PSIG TO 60 PSIG. SPECIAL TUBING MADE TO KSC SPEC-2-0007 TUBING SIZES ARE FROM 1/4" THRU 1-1/2" FOR KC103 SEAL RING SPECIAL COMPONENTS DESIGN FOR KSC *COMPONENTS ARE VALVE, REGULATOR, GAUGE, FILTER, SWITCH, TRANSDUCER, ORIFICE & SILENCER BREATHING AIR REGULATOR PANEL BREATHING AIR CHARGING PANEL EXTERIOR MANIFOLD INTERIOR MANIFOLD TEST STAND MANIFOLD MORTALITY SPARES INITIAL SPARES GFE TOTAL (TUBING & KC FITTINGS) PROJECT TOTAL COST COMPLETED

CONSTRUCTION BID DATA (10-00-43-2) PANEL COMP. PER EA * 52 1,157.34 60,187 9 1,305.67 11,751 6 1,600.00 9,603 18 1,256.00 22,608 24 2,400.75 5,778 28 1,275.36 35,710 35 937.11 32,799 148 1,205.65 178,436

BID DATE: 9-14-92 AWARD DATE: 9-24-92 AWARDED TO: CHEM-KO CLEANING \$148,222 CONSTRUCTION TIME SPAN: 300 CALENDAR DAYS NO OF BIDDERS: 5 POS. OF GOV EST * OF 5 PERCENT DIFFERENCE: 37%

BIDDERS: CHEM-KO CLEANING 1,001.50 148,222 MIMS, FL 1,068.95 160,869 COCOA, FL 1,198.94 177,581 ASTRO PAK 1,205.65 178,436 SAN DIEGO, CA 1,592.07 235,627 GOV. EST. (ADJUSTED) HIGH PURITY SYS., INC. 1,818.93 289,201 TITUSVILLE, FL

07 07 07

SYSTEM 5 SUMMARY OF GOVERNMENT ESTIMATE FOR BUILDINGS

9-14-92 SHEET 2 OF 2 309

DRAWING NO. 82K03283, 82K03286	ARCH/ENG. MCDONNELL DOUGLAS SPACE SYSTEMS CO. LDE. M. HOGUE 7-2759	PCN 96275.1	LOCATION KSC
WORK ORDER/CONTRACT NAS10-11949	ESTIMATOR E. JONES, EG&G 932.1	CHECKER R. VARDELL EG&G 832.1	
PROJECT PSF-R BREATHING AIR DISTRIBUTION, SY 14 PANELS AND SPARES		CODE C-100	COMMENTS SUBMIT 9-14-92 S.S. 11-11-92
SHEETS 13, 6 & 5		DESCRIPTION BASIC PLAN	

DIV. TITLE	QTY	UNIT	\$ UNIT	\$ TOTAL	GFE TOTAL	TOTAL WITH GFE	PANEL TOTAL	TOTAL
82K03283 BREATHING AIR REGULATOR PANEL ASSEMBLY (FRONT VIEW)								
82K03283 BREATHING AIR REGULATOR PANEL ASSEMBLY (REAR VIEW)								
PANEL ASSEMBLY -1 FRONT VIEW PANEL ASSEMBLY -1 REAR VIEW 82K03284 BREATHING AIR CHARGING PANEL ASST.								
EXTERIOR MANIFOLD ASSEMBLY - 1								
INTERIOR MANIFOLD ASSEMBLY - 2								
TEST STAND MANIFOLD ASSEMBLY - 3								

CONSTRUCTION BID DATA (FB 10-0043-2)

PANEL COMP. (PER EA)	52	1,157.44	60,187
PANEL COMP.	9	1,305.67	11,751
MANIFOLD COMP.	6	1,600.50	9,603
MANIFOLD COMP.	18	1,256.00	22,608
MANIFOLD WELD BOSS	24	240.75	5,778
M. SPARES COMP.	28	1,275.36	35,710
L. SPARES COMP.	35	937.11	32,799
TOTAL PROLL COMP.	148.00	1,205.65	178,436

BID DATE: 9-14-92 AWARD DATE: 9-24-92
 AWARDED TO: CHEMKO CLEANING \$148,222
 CONSTRUCTION TIME SPAN: 300 CALENDAR DAYS
 NO OF BIDDERS: 5 POS. OF GOV EST 4 OF 5
 PERCENT DIFFERENCE: 37%

BIDDERS	COST PER COMPONENT	BID AMOUNT
CHEMKO CLEANING	1,001.50	148,222
MIMS, FL		
PRECISION FABRICATING	1,086.95	160,660
COCOA, FL		
ASTRO PAK	1,198.94	177,591
SAN DIEGO, CA		
GOV. EST. (ADJUSTED)	1,205.65	178,436
GOV. EST. (ORIGINAL)	1,592.07	235,627
HIGH PURITY SYS., INC.	1,818.83	268,201
TITUSVILLE, FL		

COMPUTER ANALYSIS - LDE / LCE
 WHAT IF? MARK-UPS -

SSPF BID - GOVERNMENT ESTIMATE
 JANUARY 8, 1991

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APPROV
 JCB
 1/17/91

TAKS	AMOUNT	TOTALS
TASK I		
A. CIVIL	6,845,143	
B. ARCH/STRUCTURAL	26,192,370	
C. MECHANICAL	11,230,209	
D. ELECTRICAL	4,857,869	
E. CAFETERIA	1,048,035	
F. VVG	953,784	\$49,125,591
G. R&D	1,312,349	
H. R&PM	3,111,989	
		\$55,551,748
SPECIAL CONDITIONS	0	
ESCALATION	0	
		\$0
AMENDMENT NO. 2	1,224,231	
		\$56,775,979
-4% PROFIT MARKUP	(2,271,039)	
-4% MATERIAL DISCOUNT	(2,271,039)	
		\$52,233,901
TOTAL TASK I		\$52,233,901
TASK II (HVAC CONTROLS)	353,824	
TASK III (PREMISES)	1,766,968	
TASK IV (SECURITY)	98,956	
TASK V (ENVIRONMENTAL)	55,237	
		\$2,274,985
TOTAL TASK II-V		\$2,274,985
		\$54,508,886
TOTAL BID		\$54,508,886
TASK VI (NEW CHILLER)		\$1,735,898
TASK VII (POWER FEEDER)		\$617,199
		\$56,861,983
TOTAL BID WITH OPTION		\$56,861,983
		\$56,861,983
		\$11,941,016
		\$10,608,462
COFF	\$50,516,484	\$10,608,462
R&D	\$3,233,510	\$679,037
R&PM	\$3,111,989	\$653,518
	\$56,861,983	\$11,941,016

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SYSTEM SUMMARY OF GOVERNMENT ESTIMATE FOR BUILDINGS												
DRAWING NO.		SHEETS		PCN		LOCATION		PROJECT				
79K05423		186		76389		KSC LC-39 (West of YAB)		Orbiter Processing Facility Phase I				
WORK ORDER CONTRACT		ARCHITECT ENGINEER		ESTIMATOR		CHECKER		CODE C 100				
PRC 0897 NAS10.8840		See/lye, Stevenson, Value & Knecht, N.Y.C. (SSVK)		KAAS, SSVK/Pierce, PRC		GMC, SSVK/Thomson, PRC		SUBMITTED 3/30/81 NOT ESCALATED				
CONSTRUCTION COSTS												
QTY	UNIT	S/UNIT	S/BSP	TOTAL	DIV. TOTAL	9 FINISHES	UNIT	S/UNIT	S/BSP	TOTAL	DIV. TOTAL	COMMENTS
40,070	CY	40.59	30.81	1,611,180			52,800	SF	1.63	1.63	85,978	Union Construct. Completed 4/25/77
14	ACRE	1128.		1,626,570			6,249	SF	1.54	.18	9,611	
1,133	SY	31.19	.67	35,339			11,324	SF	1.41	.30	15,953	
40,070	CY	3.37	2.56	134,950			10,362	SF	4.42	.87	45,761	
34,594	LF	9.98	6.54	345,127			32,466	SF	0.43	.27	14,047	
5,099	EA	27.81	1.88	39,306			34	EA	17.83	.01	606	
15,417	SY	48.02	14.02	740,468			21,700	SF	4.67	1.92	101,373	
3,238	CY	139.60	8.56	452,039			21,700	SF	4.67	1.92	101,373	
32,800	SF	1.62	1.00	53,047			52,300	SF	.14	.14	7,361	
228	TON	1082.	4.67	246,629			Various		.14	.14	7,361	
3,198	CY	46.70	2.83	149,334								
40	CY	75.73	.06	3,029								
31,540	SF	2.79	1.67	88,086			643.8	TON	2672	32.58	1,720,272	
31,540	SF	2.78	1.66	87,622			1,570	LF	175.64	5.99	*316,147	
145	LF	3.20	.01	464			1	SYS	72,724.	1.38	72,724	
1,353	TON	1208.	30.96	1,634,460			3,470	SF	41.85	2.69	*142,291	
1,128	TON	1092.	23.32	1,231,253			4,233	LF	18.88	1.77	93,489	
175	TON	1149.	3.81	201,130			6,629	LF	19.13	2.40	126,785	
101,380	LB	1.12	2.15	113,554			643.8	TON	1505.	18.35	988,336	
8,499	SF	1.66	.27	14,089								
7,000	SF	1.71	.23	11,926								
52,800	SF	9.61	9.61	507,635			2,334	KVA	418.	20.83	1,100,067	
442	LF	0.43	.004	192			437	EA	114.48	.88	46,594	
53,119	SF	0.34	.34	18,161			215,560	LF	0.33	1.36	71,646	
52,800	SF	0.67	.67	35,299			49,158	LF	1.30	1.21	64,054	
55,072	SF	5.64	5.80	306,416			39,653	LF	3.80	2.85	*150,658	
52,800	SF	2.19	2.19	115,719			1	SYS	116,156	2.20	116,156	
5,899	SF	5.40	.60	31,848			2,634	KVA	118.35	5.90	*311,745	
37	EA	9830	6.89	363,707			225	EA	37.19	.16	8,368	
30	EA	410.37	.23	12,311			310	LF	14.81	.09	*4,592	
4,510	SF	74.50	6.36	335,997			17	EA	920.	.30	15,639	
288	SF	8.81	.05	2,537			6	EA	1092.	.12	6,553	
1	EA	12,362	.24	12,362								
PROJECT TOTALS										7,701,637		

DESIGN DATA
 BLDG. TYPE: Airplane Hangar
 CAPACITY: One S1S (Orbiter)
 STRUC. FRAME: Steel
 EXTERIOR WALL: Metal Siding w/ Insul. & Conc. Blk.
 HEIGHT: One STORIES 95'-HB FT. 25'-LB
 GROUND FLOOR AREA: 52,800 SF
 TOTAL FLOOR AREA: 52,800 SF
 VOLUME: 3,240,717 CF S2.93 CPC
 PERCENT AIR CONDITIONED: 100% 643.8 TONS
 OTHER: HB 197' X 150' LB 236' X 98'

Gov't. Est. made by SSVK and modified by PRC and DD-SED. Burdens: P.T. & 1. 20% S. Tax 4%, O-Head 3%, Profit 5%, Bond 1%, Escalation 5%. A/C for AHU only, chillers part of YAB A/C Sys.
 *Exterior Mech. & Elec. & Site Work
 CONSTRUCTION BID DATA (PRC 10-0028-5)
 TOTAL BLDG. SF: 52,800
 ARCH/STRUC. \$ 01.64 BSF \$ 3,254,728
 INTERIOR MECH \$ 23.90 BSF \$ 1,261,834
 INTERIOR ELEC. \$ 11.99 BSF \$ 633,072
 TOTAL INTERIOR \$ 97.53 BSF \$ 5,149,634
 TOTAL EXTERIOR \$ 48.33 BSF \$ 2,552,003
 TOTAL CONSTR. \$ 145.86 BSF \$ 7,701,637
 ADDITIONAL 6 Amends .69 BSF \$ 36,675
 Spl. Cond. \$ 14.43 BSF \$ 761,816
 TOTAL PROJECT EST \$ 160.99 BSF \$ 8,500,128
 BID DATE: 5-14-75 A 5/27/75 C 3/15/77
 AWARDED TO Frank Briscoe, Inc. \$ 8,733,300
 CONSTRUCTION TIME SPAN: 600 CALENDAR DAYS
 NO. OF BIDDERS: 12 POSITION OF GOVT. EST. 1
 PERCENT DIFFERENCE: AWARDED BID AND GOVT. EST. 2.7

Gov't. Estimate
 Frank Briscoe, Inc. \$ 8,500,128
 Continental Consol. \$ 9,077,000
 Tuttle White Con. Co. \$ 9,095,000
 J.A. Jones Con. Co. \$ 9,199,000
 Butler & Dembrink \$ 9,362,000
 Bay-Con General \$ 9,523,000
 McToskey Co. Inc. \$ 9,590,000
 McHanus, Longe, Brookwell, \$ 9,716,000
 R&D Constructors, Inc. \$ 9,744,500
 Greenhut Con. Co. (Inc) \$ 10,592,000
 Morrison-Knudsen, Inc. \$ 10,592,000

AUTHOR BIOGRAPHICAL DATA



Name: Joseph A. Brown

Position: Senior Advisor and Coordinator for
Development of Cost Engineering and
Estimating

Company: NASA/KSC, FL

Address: DF-FED, Kennedy Space Center, FL 32899-0001

Paper Title: Estimating and Bidding for the Space Station Processing Facility

Professional Experience: Joseph A. Brown, CCE, has prepared and reviewed construction cost estimates amounting to over \$8 billion. He is a graduate of the University of Florida with a bachelor of building construction, BBC (1959). He has been a consultant to commercial, industrial and residential complex interests in several states including work for the Walt Disney World Contemporary Resort Hotel. He has received AACE's Fellow Award and the Charles V. Keane Distinguished Service Award, and the prestigious astronauts "Silver Snoopy," and the NASA Commendation Award for professional excellence and his contributions to the success of the manned space efforts. He has successfully prepared estimates for the U.S. Army Corps of Engineers and Air Force facilities. Mr. Brown has written an estimating workbook and is writing a text book, "Estimation of Construction Cost and Cost Engineering." He is currently employed by NASA at Kennedy Space Center, where he specializes in construction cost engineering as Senior Advisor and Coordinator for Development of Cost Engineering and Estimating.

Education: Bachelor of Building Construction, BBC, 1959, University of Florida

Professional Society Affiliations: AACE Member

Publications, Papers and Patents: 26 Technical Papers on Cost Engineering, etc.

Honors Received: AACE "Fellow", "Silver Snoopy", Charles V. Keane Distinguished Service Award, NASA Commendation Award

VISUAL AIDS REQUIREMENTS

None

35 mm Projector

Overhead Projector

Other (Specify): Movie Screen, Chalk Board or Flip Chart, Lapel Mike